



Monica Menendez

in collaboration with

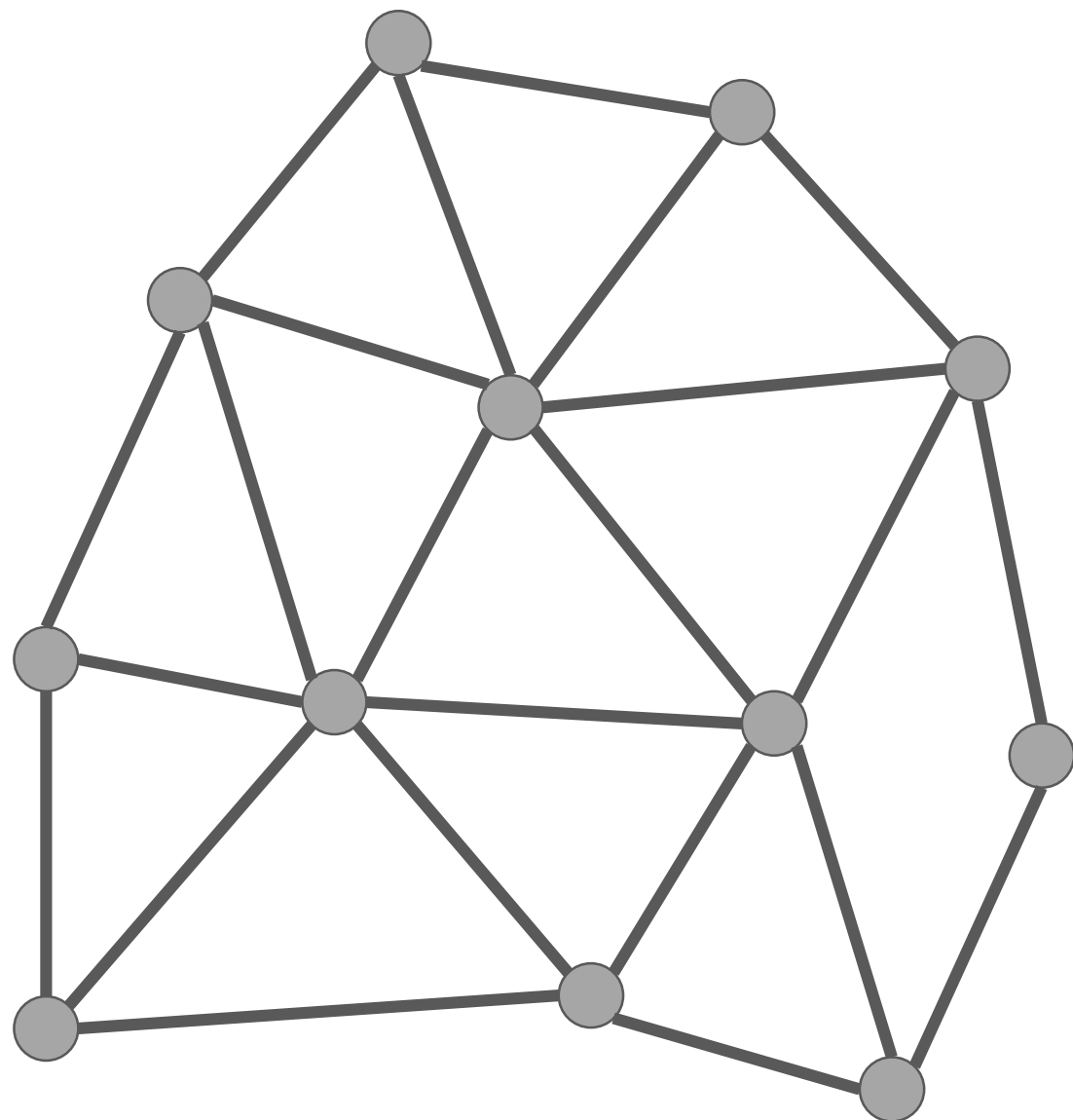
Lukas Ambuhl, L. Olmos, M. Gonzalez, A. Loder, K. Axhausen, L. Leclercq

Delft, February 2020

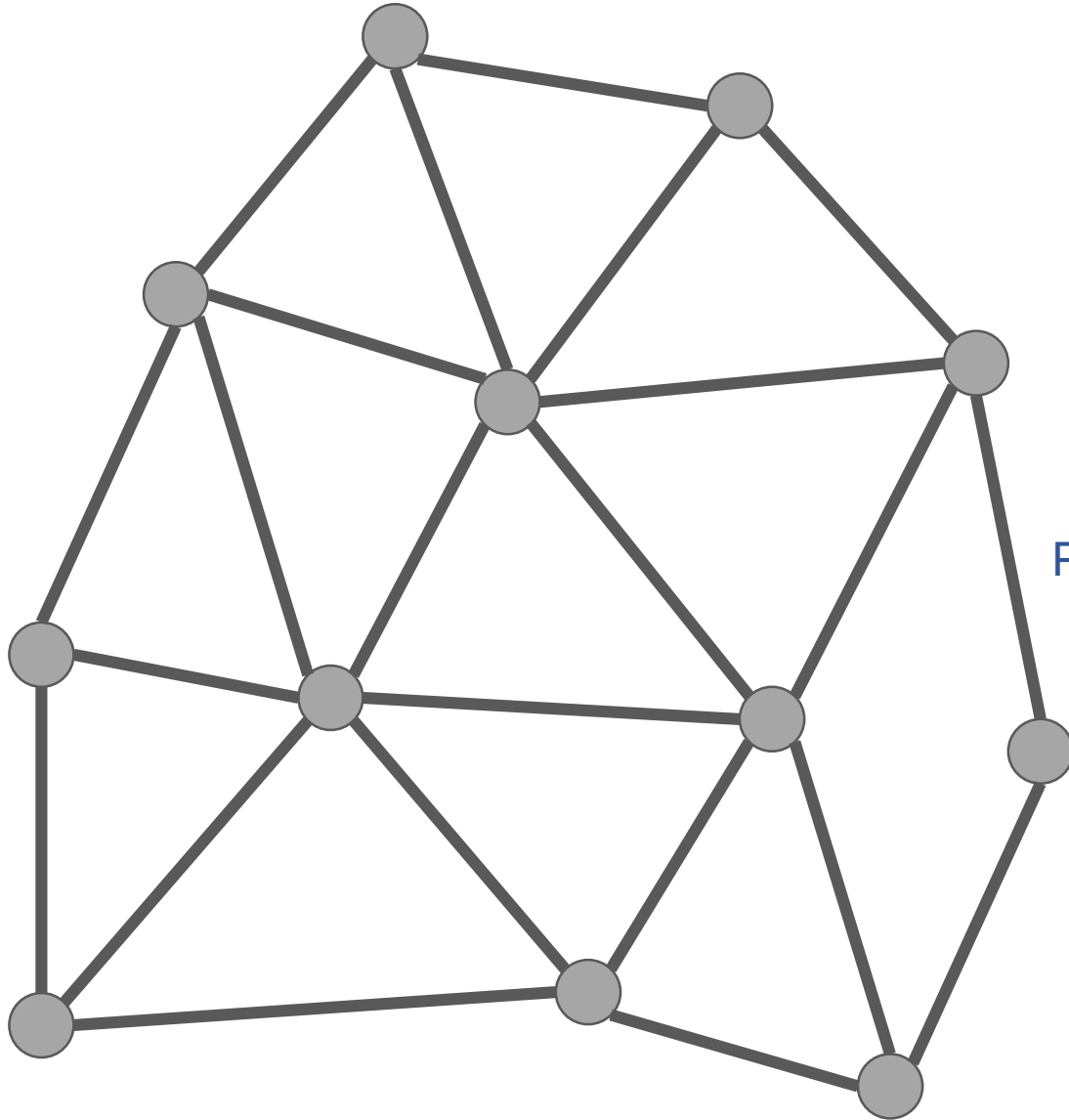
ROAD NETWORK CAPACITY: *ARE WE THERE YET?*



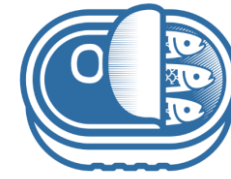
Macroscopic Fundamental Diagram (MFD)



Macroscopic Fundamental Diagram (MFD)



Flow (q)



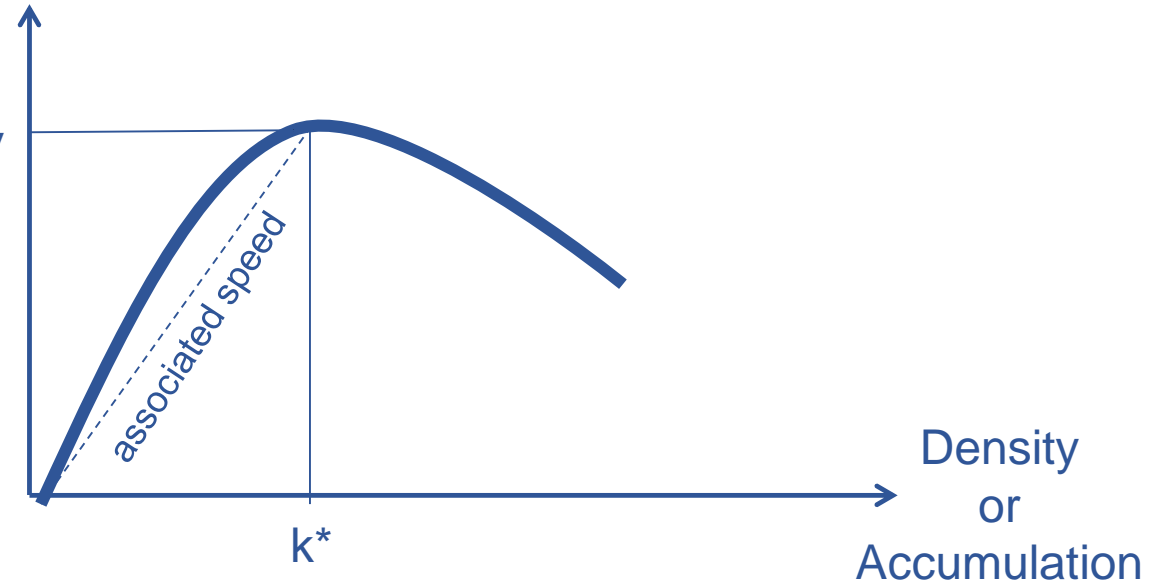
Density (k)

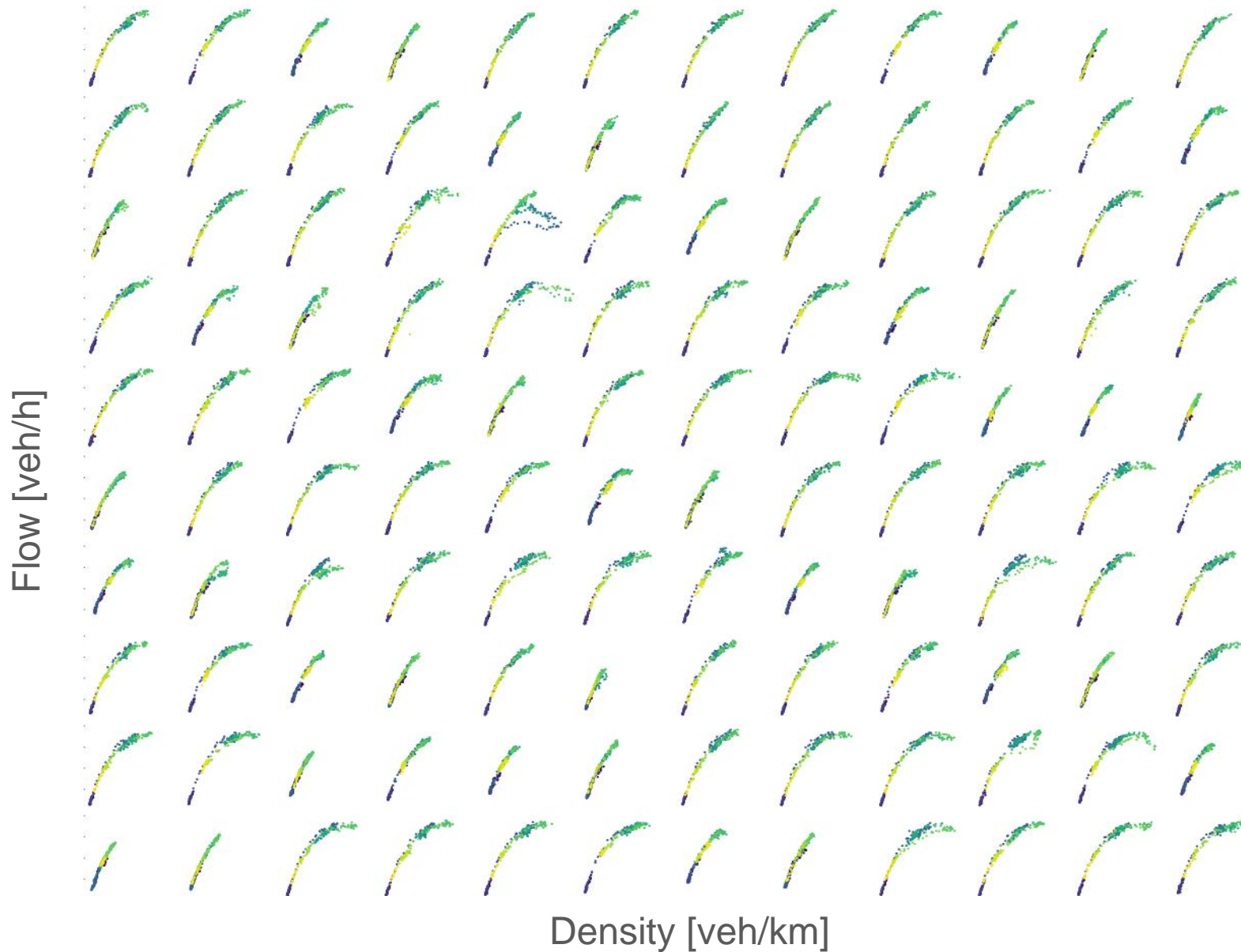


Speed (v)

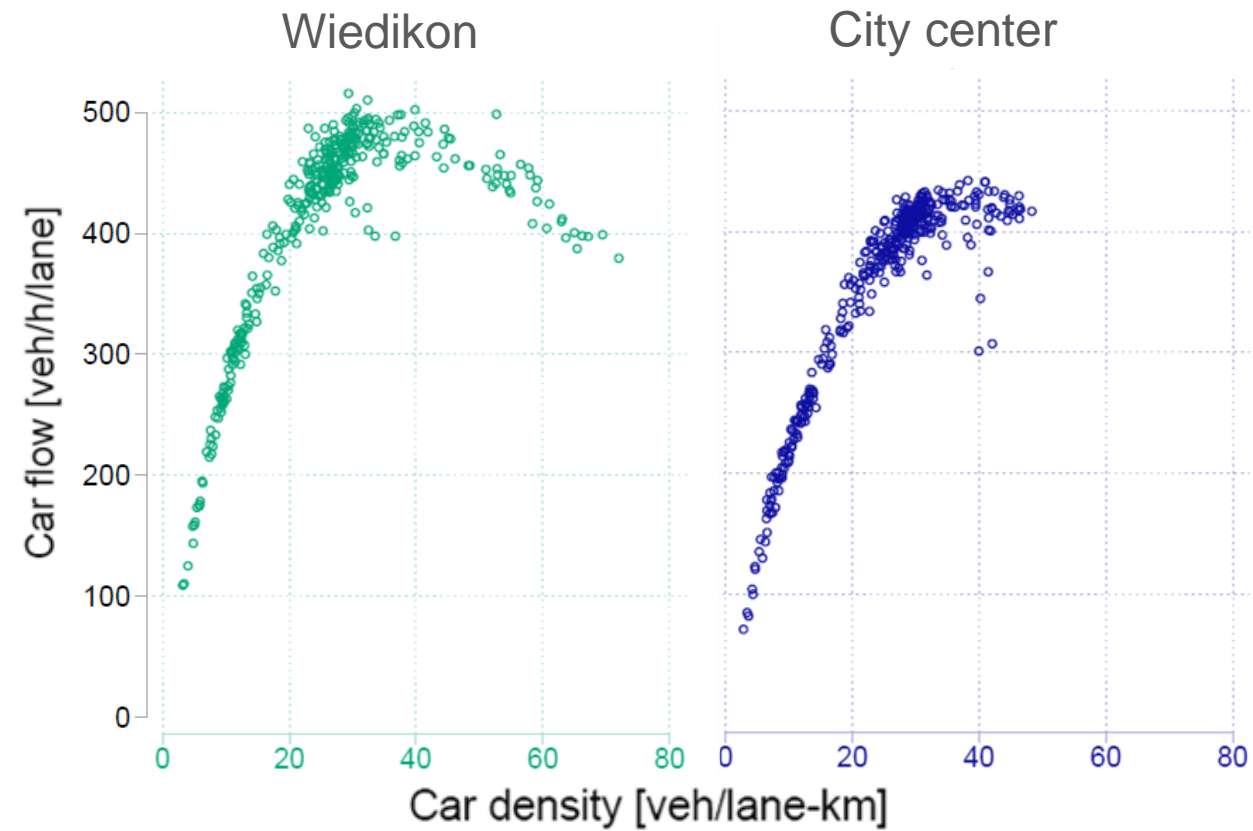
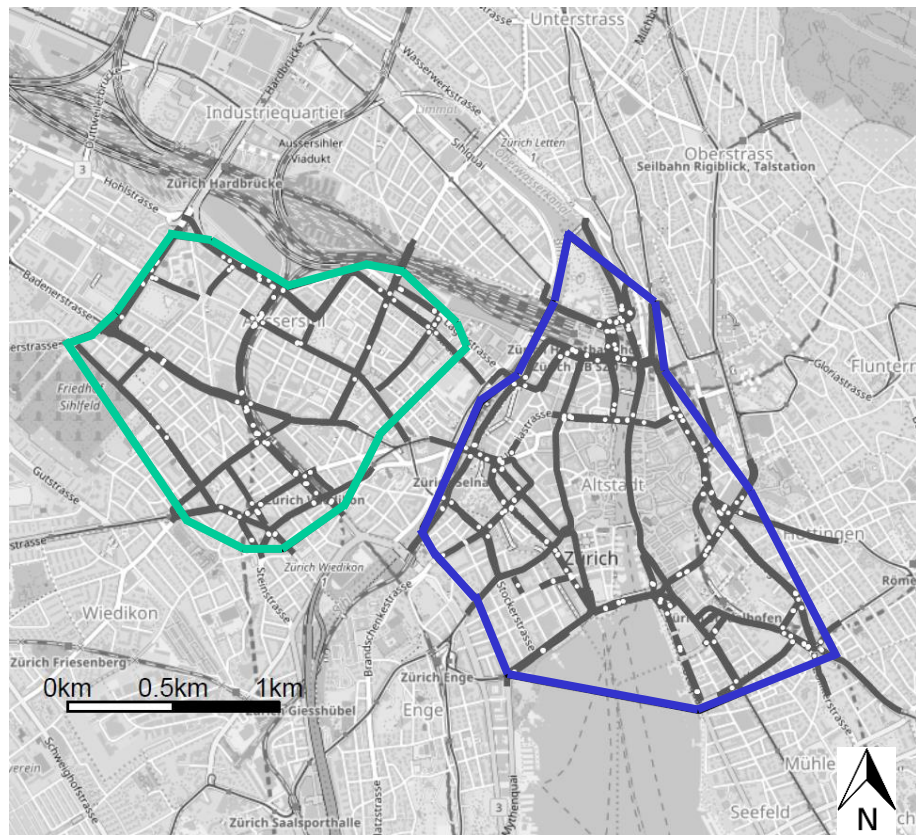
Flow
or
Production

Capacity

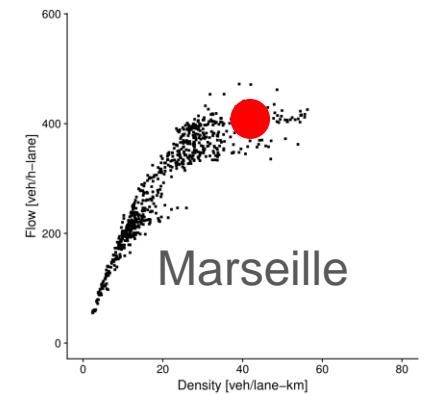
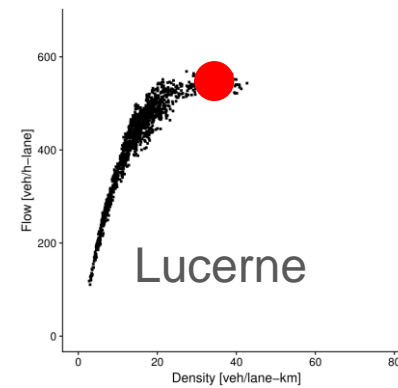
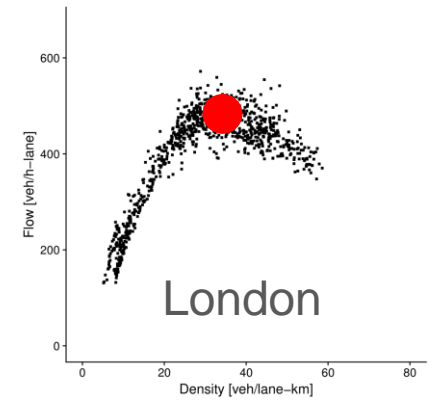
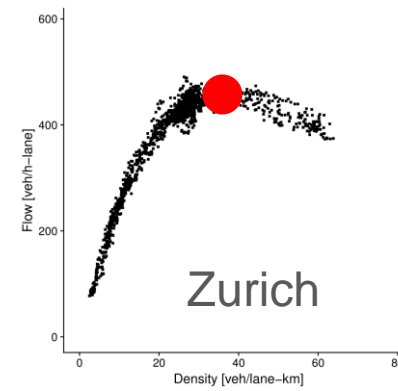
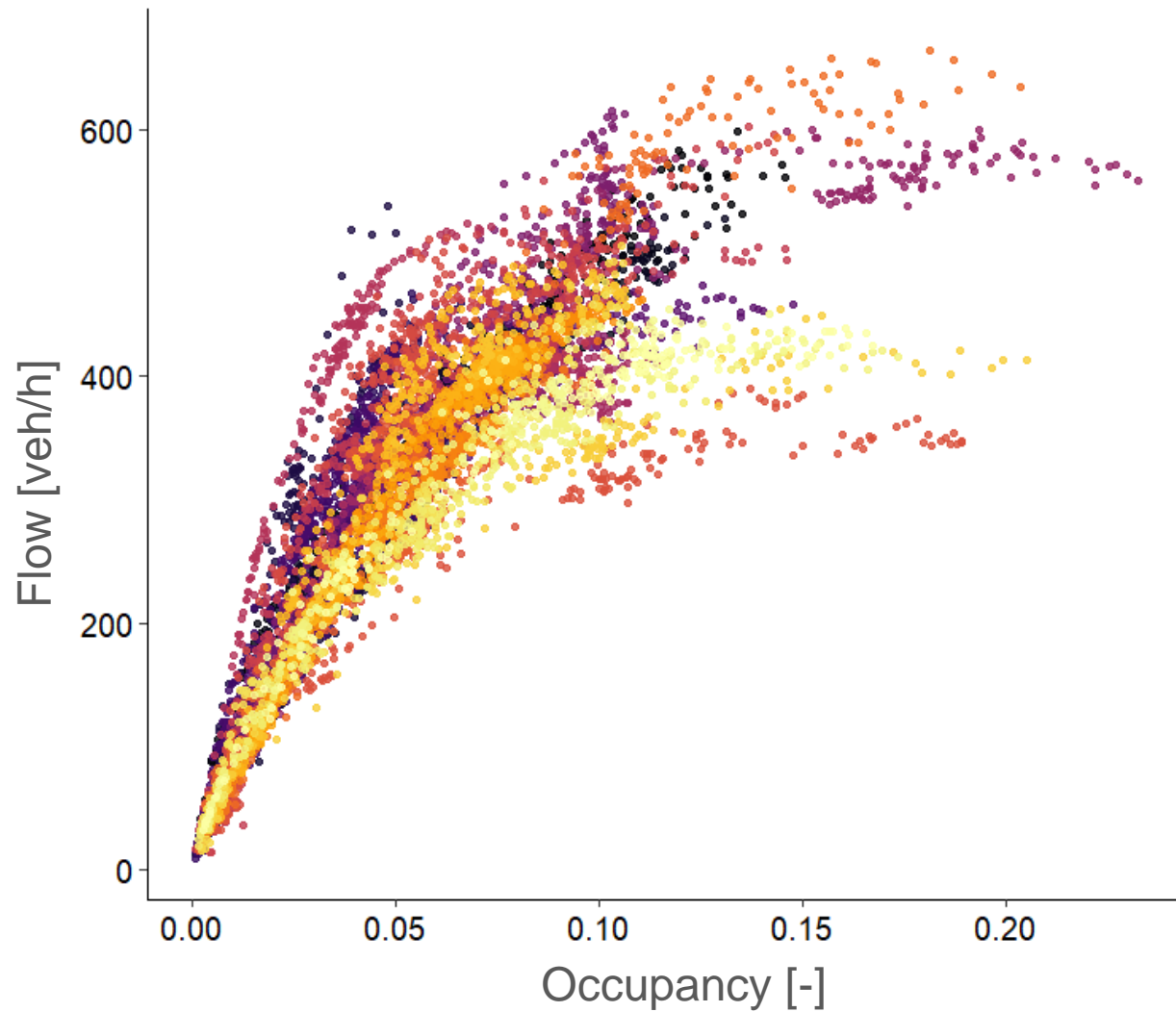


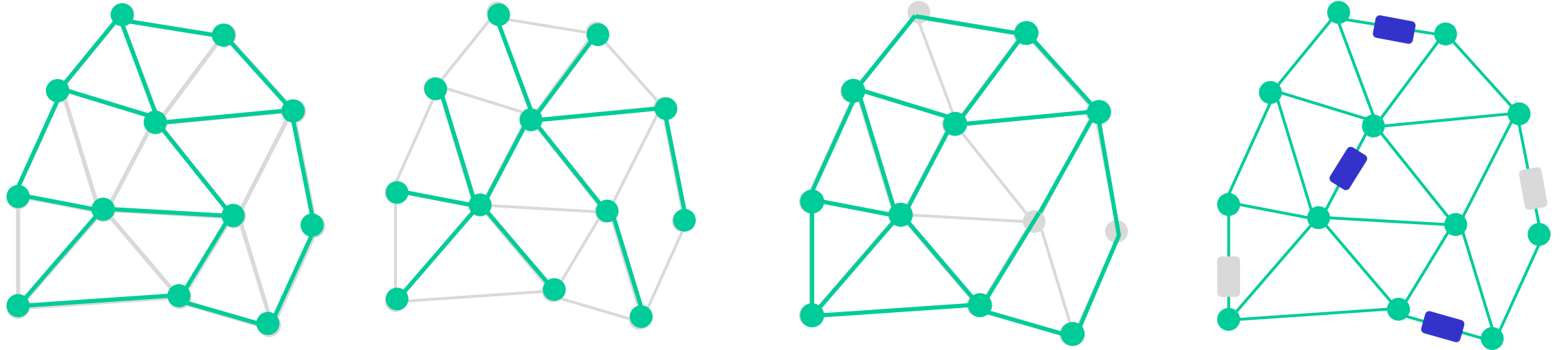
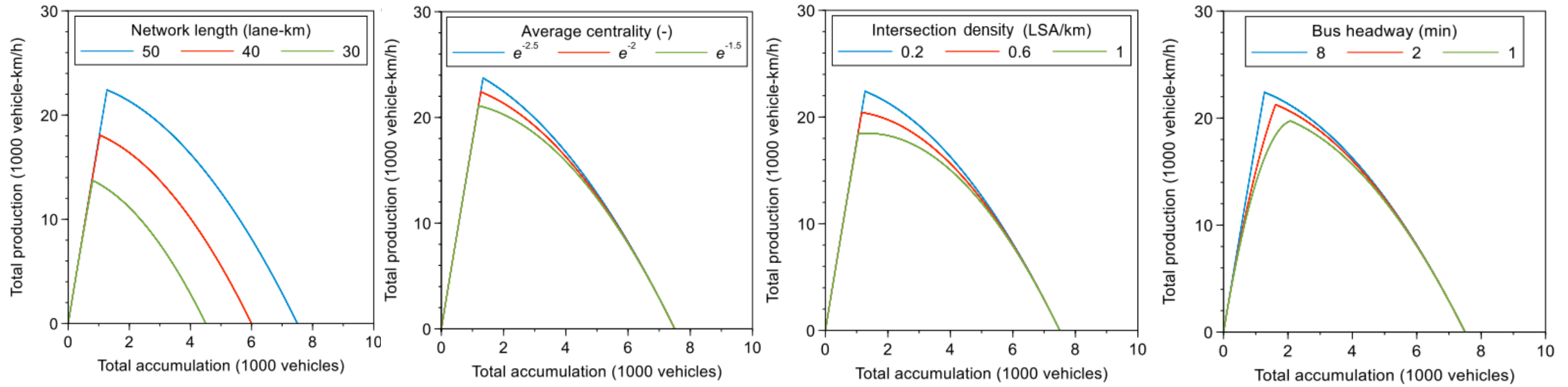


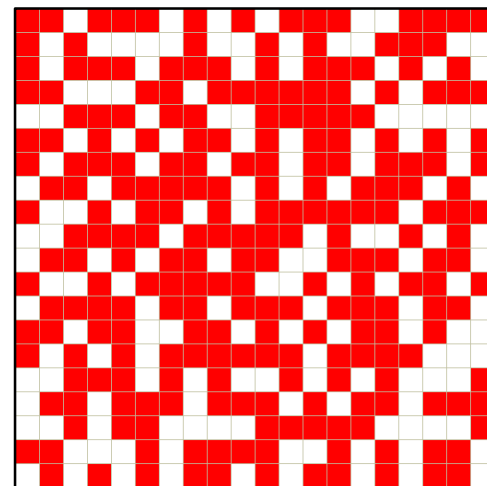
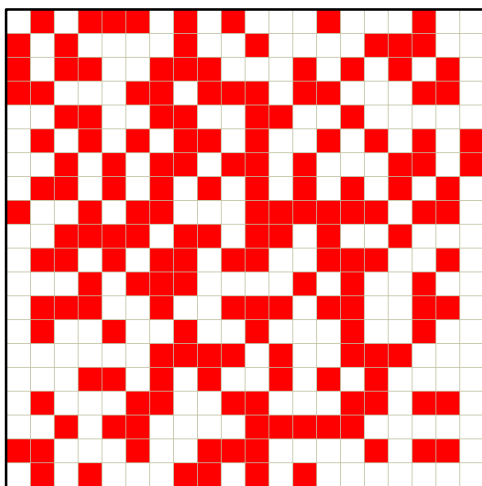
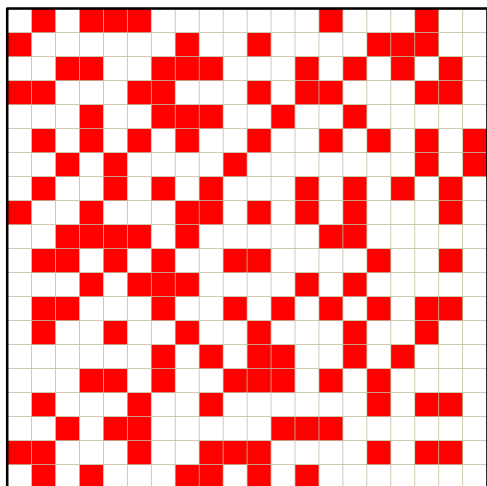
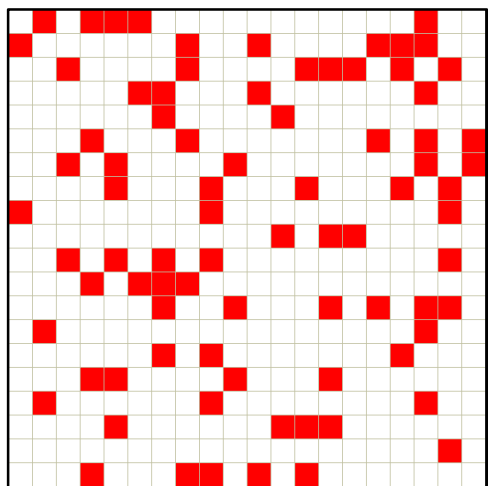
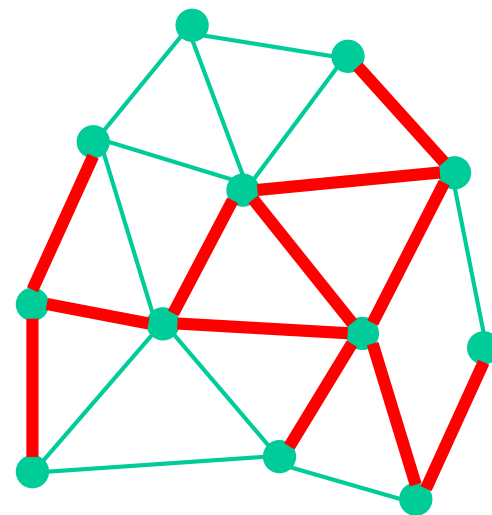
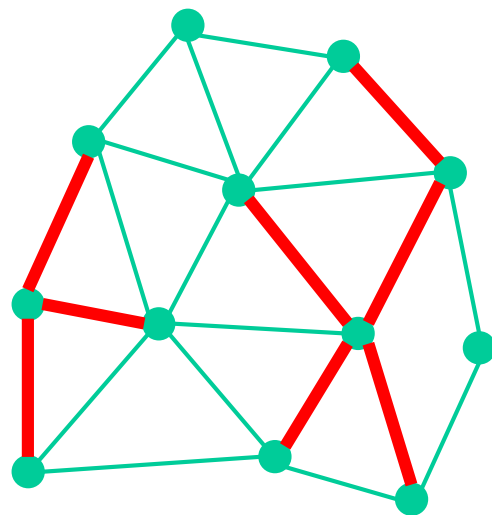
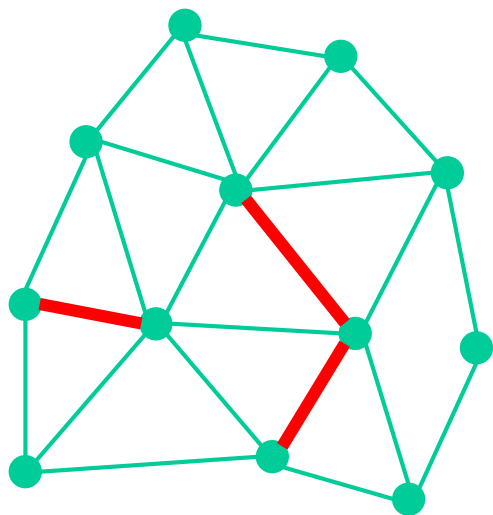
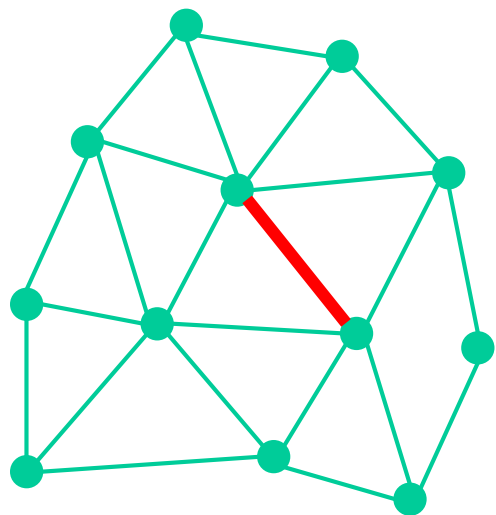
- well defined and reproducible
- network specific
- invariant to small O/D changes
- analytical approximations for simple networks exist
- consistent with traffic physics
- elegant macroscopic control



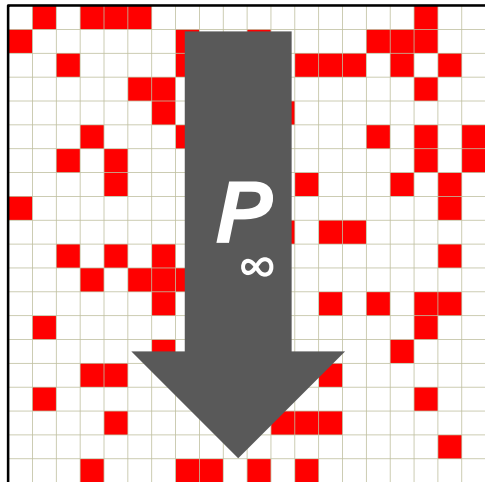
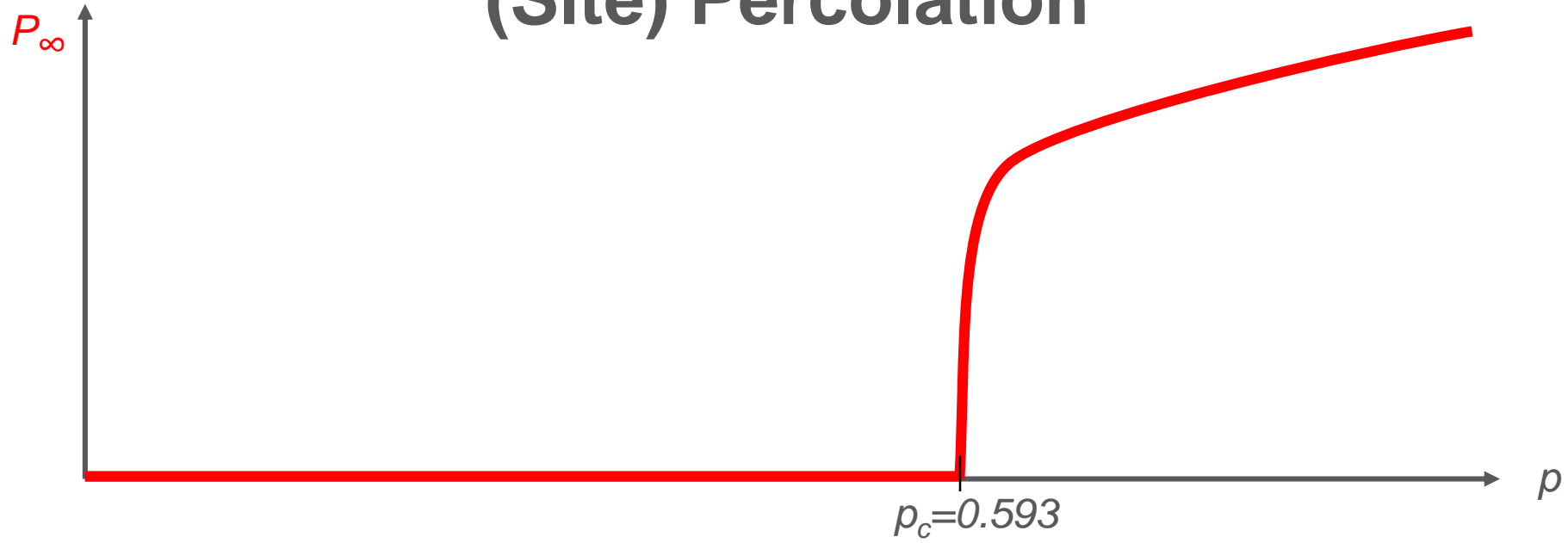




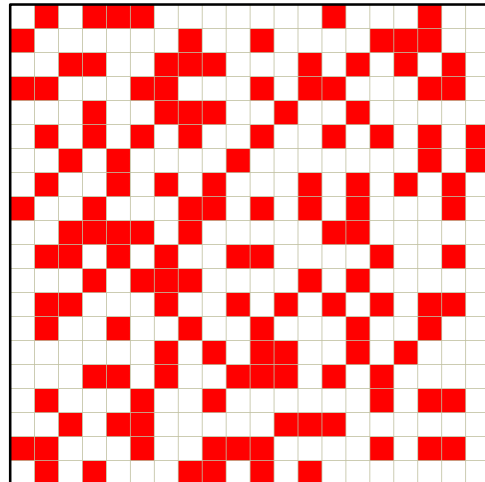




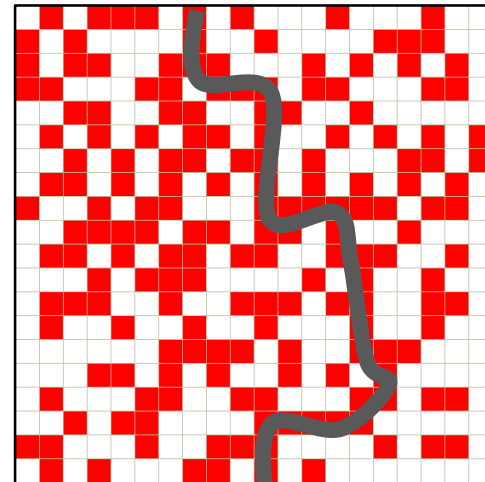
(Site) Percolation



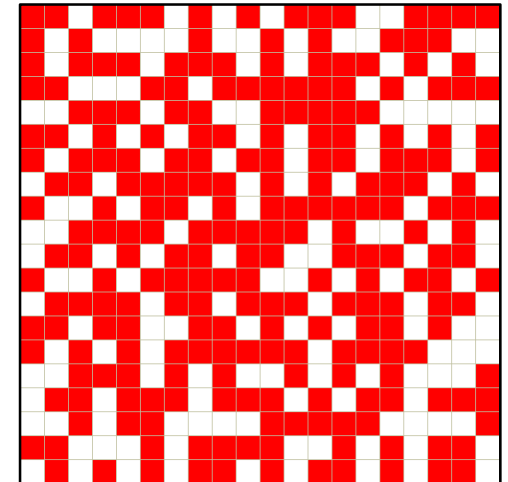
$p=0.2$



$p=0.35$

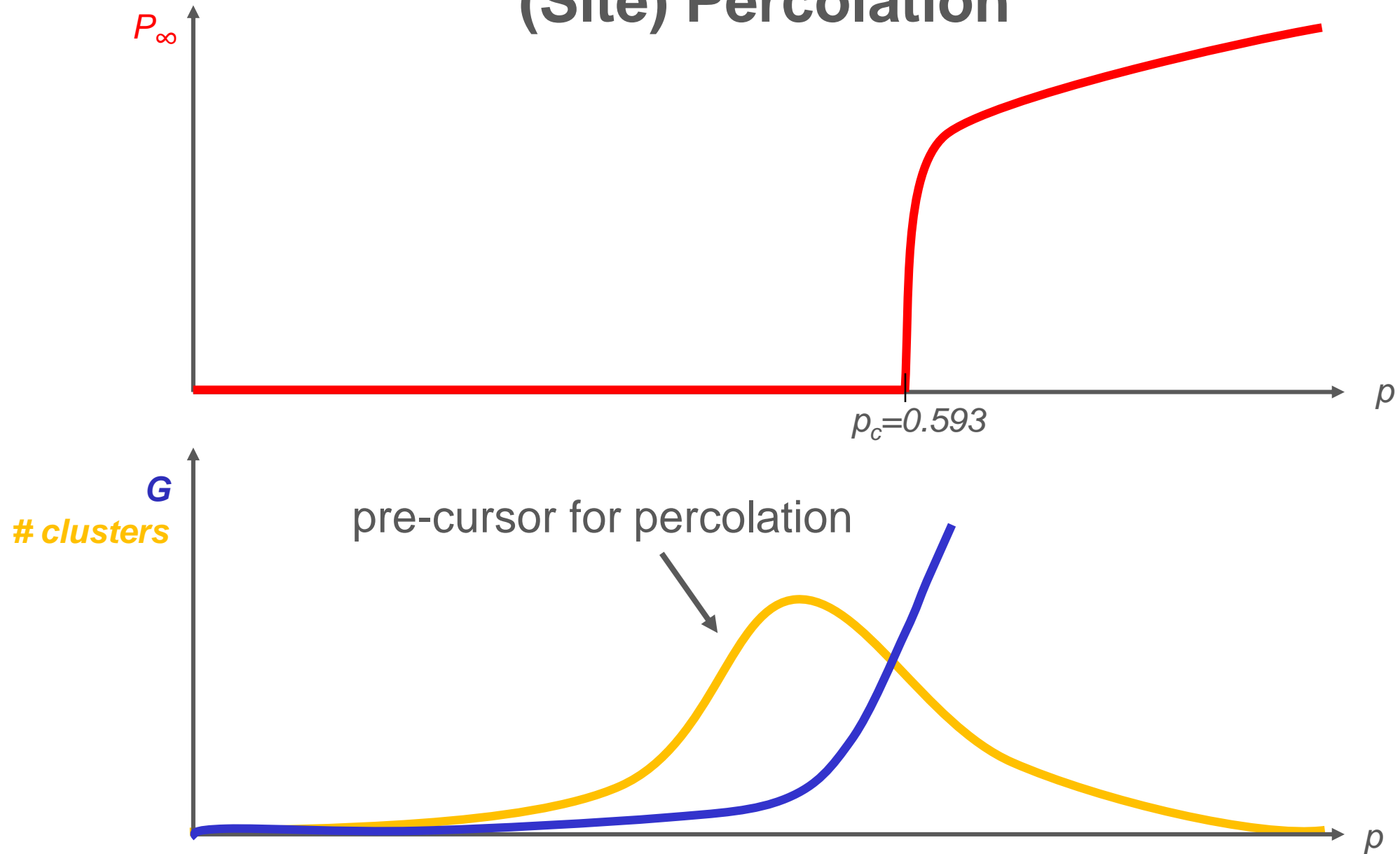


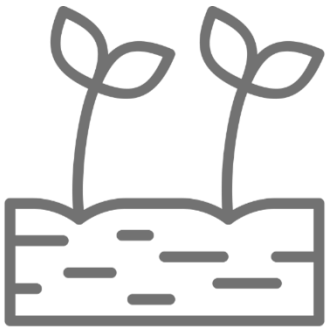
$p=0.6$



$p=0.8$

(Site) Percolation

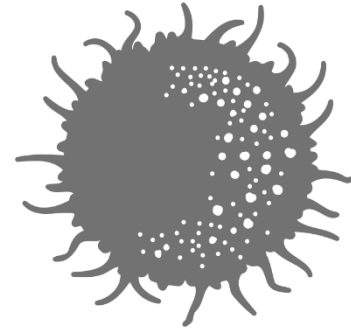




soil permeability



ferromagnetism



epidemic spreading



internet



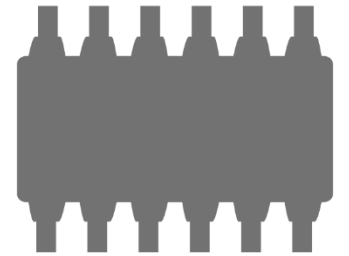
wildfires



polymerization



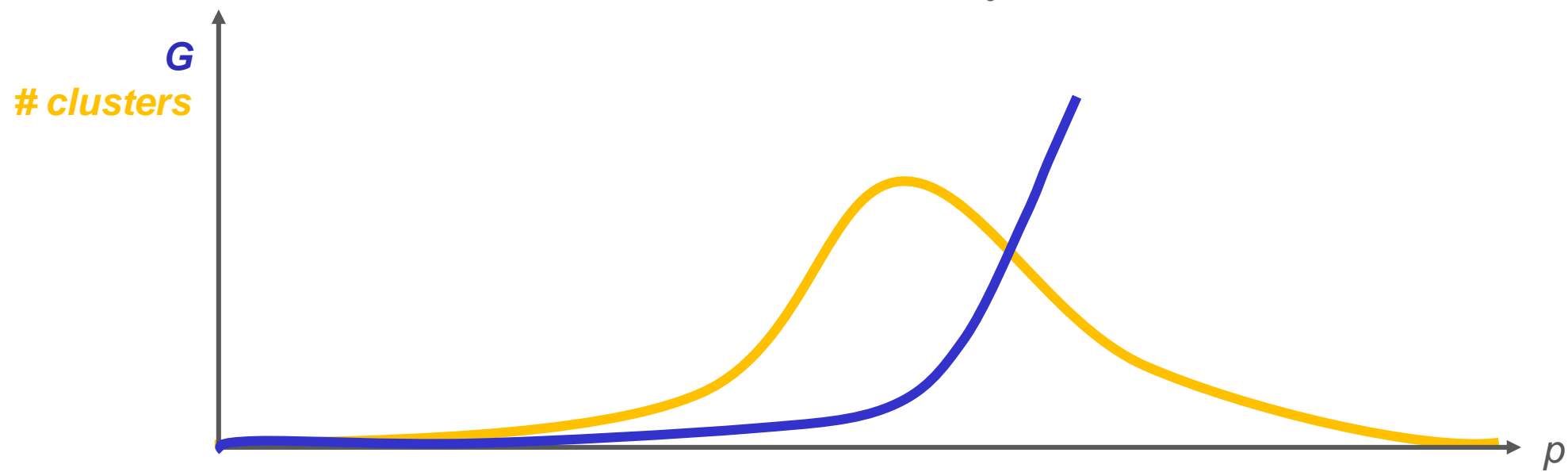
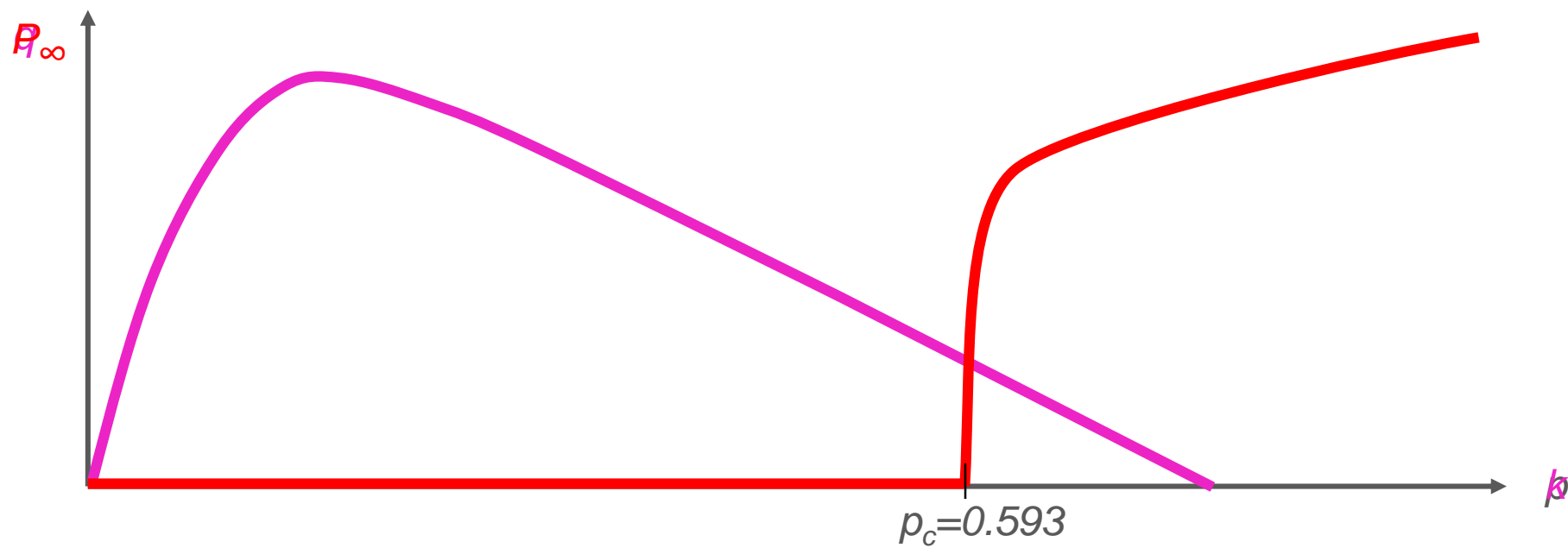
galaxy structure

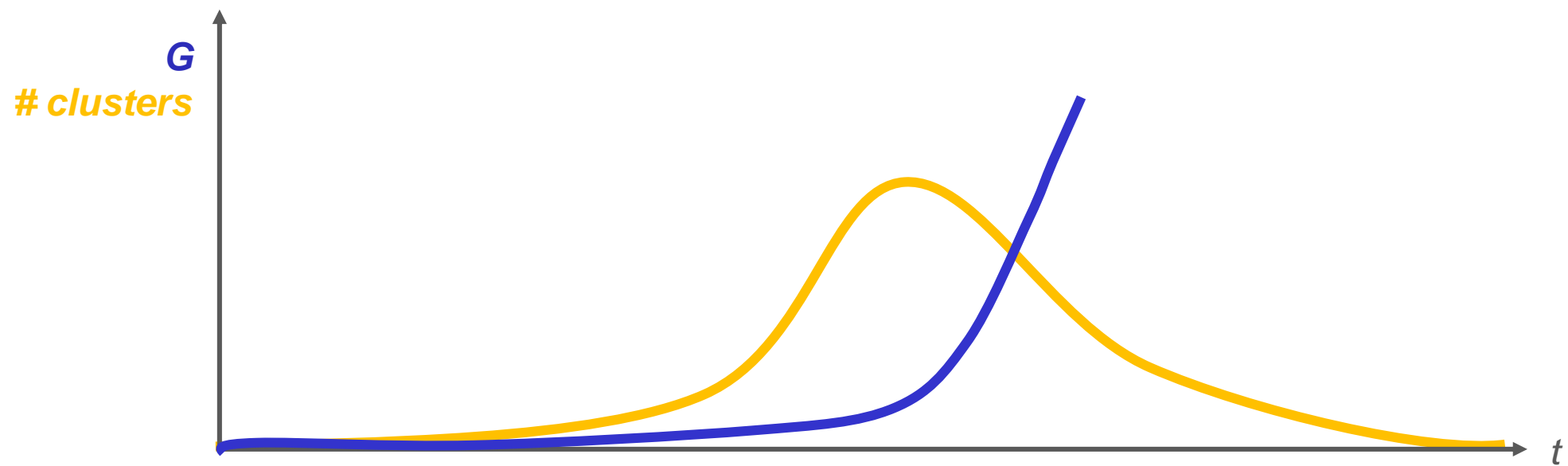
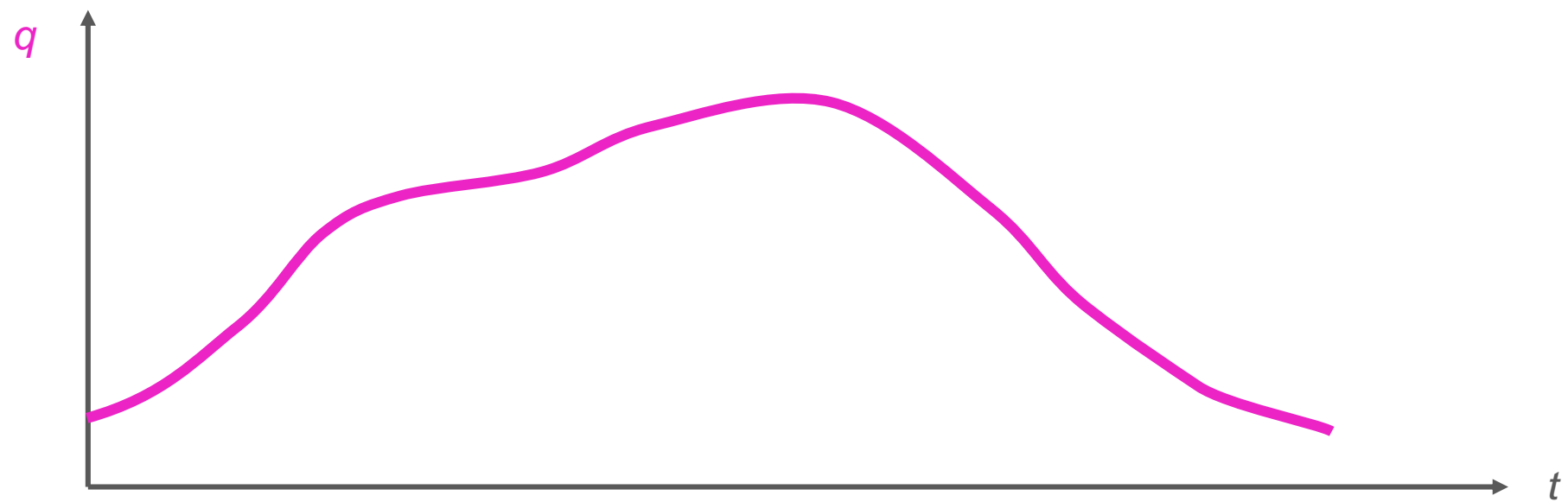


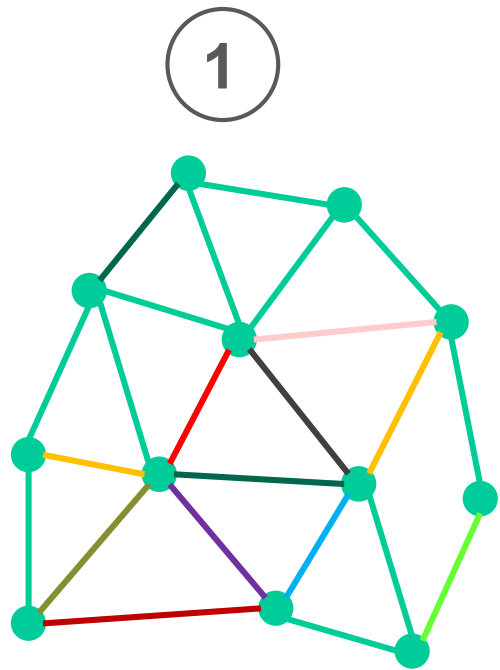
superconductors



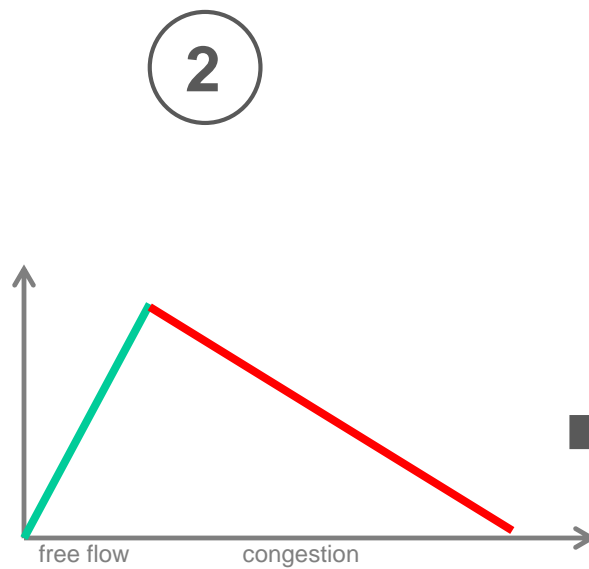
traffic congestion?



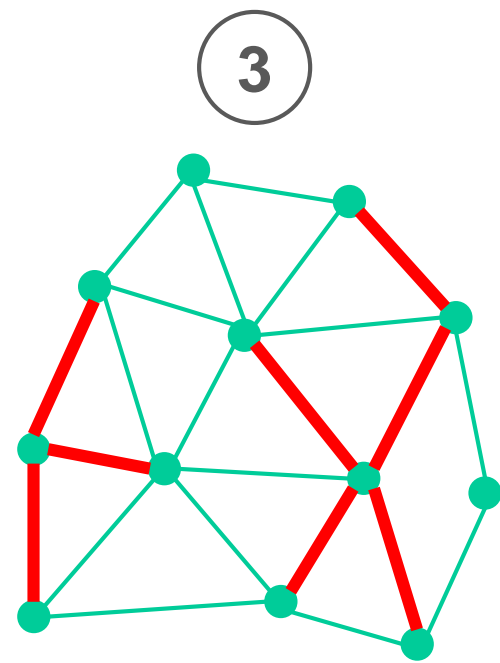




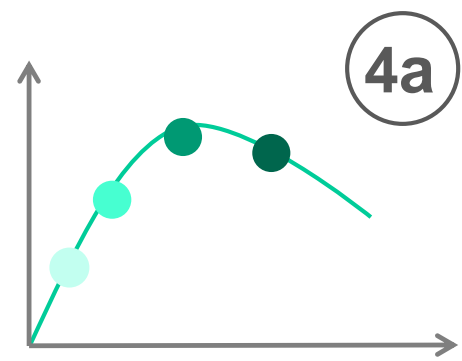
Run realistic
large-scale
simulation



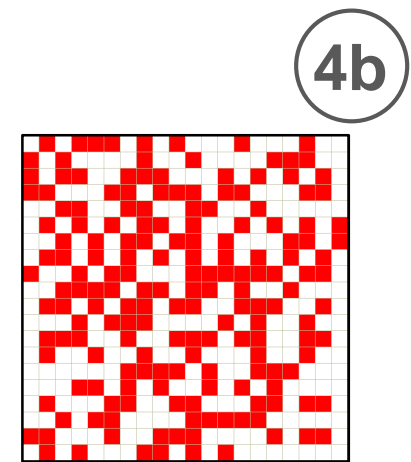
Label
congested
links



Identify
congested
clusters

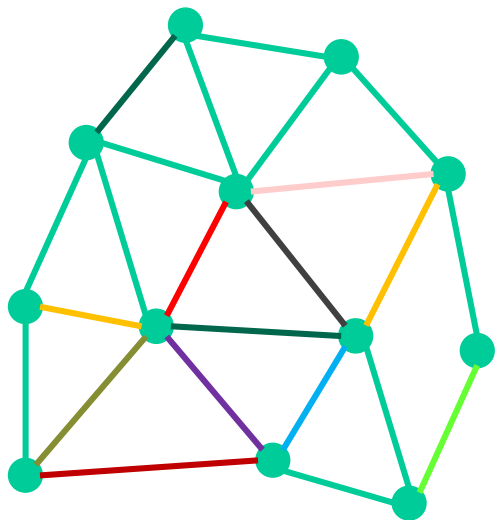


Track traffic
performance



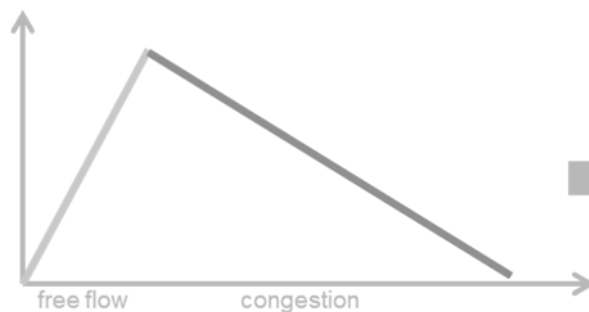
Track
percolation
metrics

1



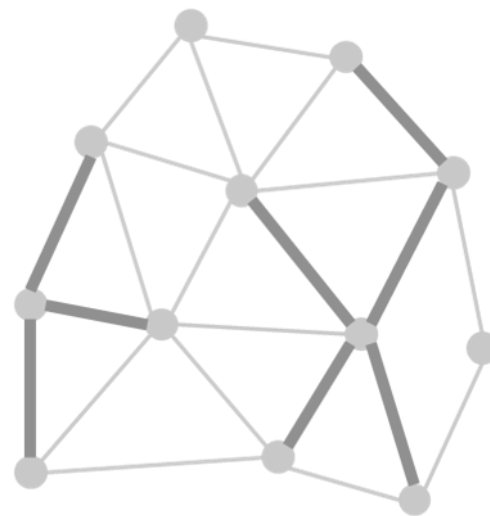
Run realistic
large-scale
simulation

2



Label
congested
links

3



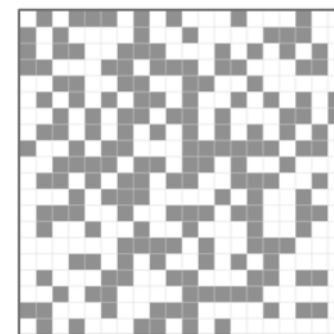
Identify
congested
clusters

4a



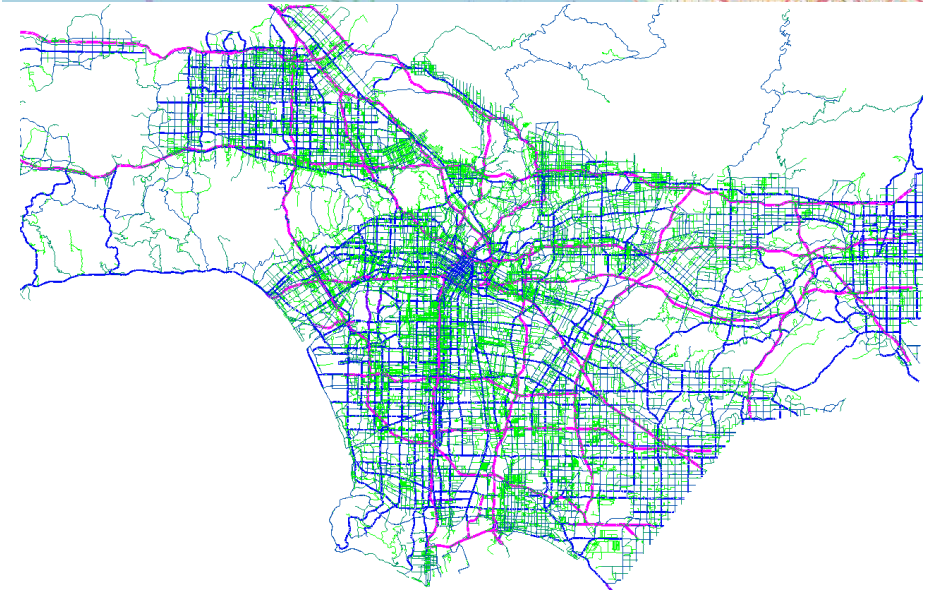
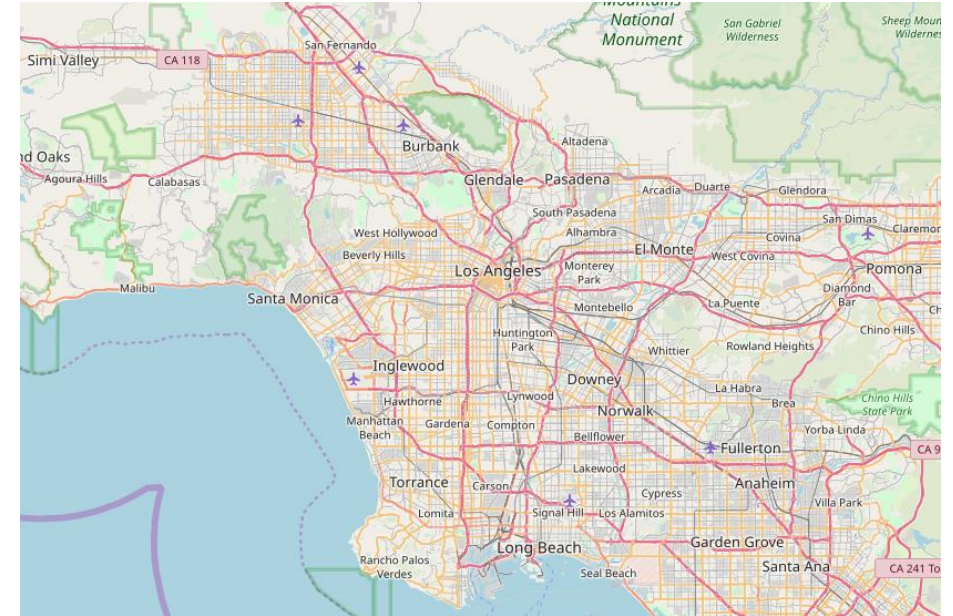
Track traffic
performance

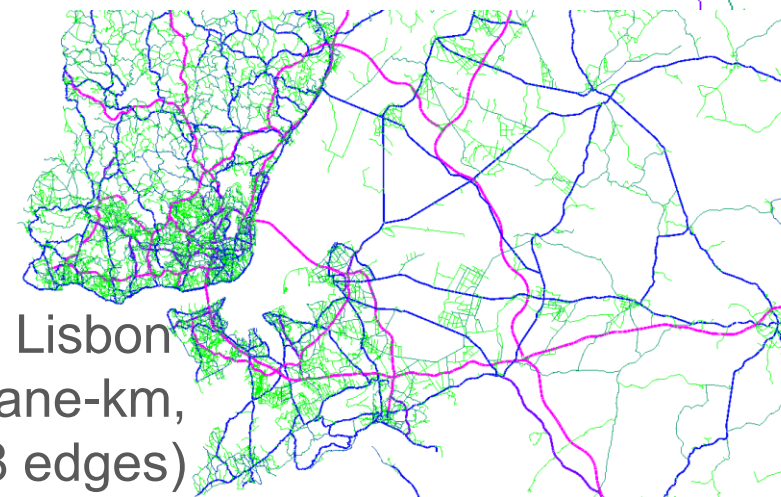
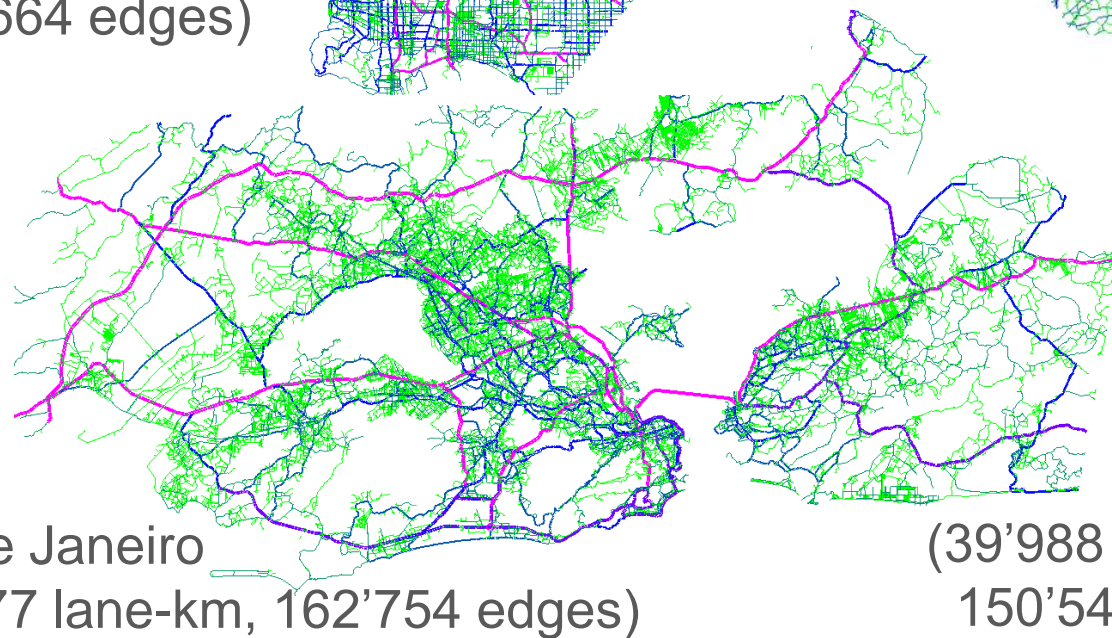
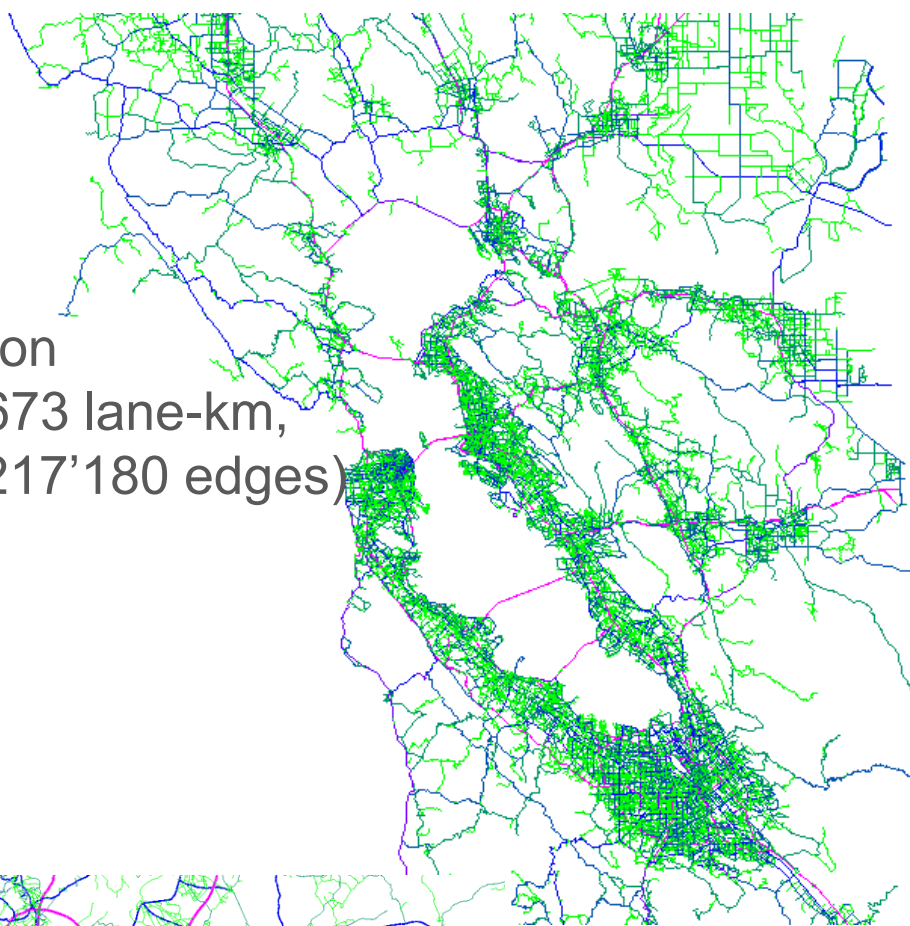
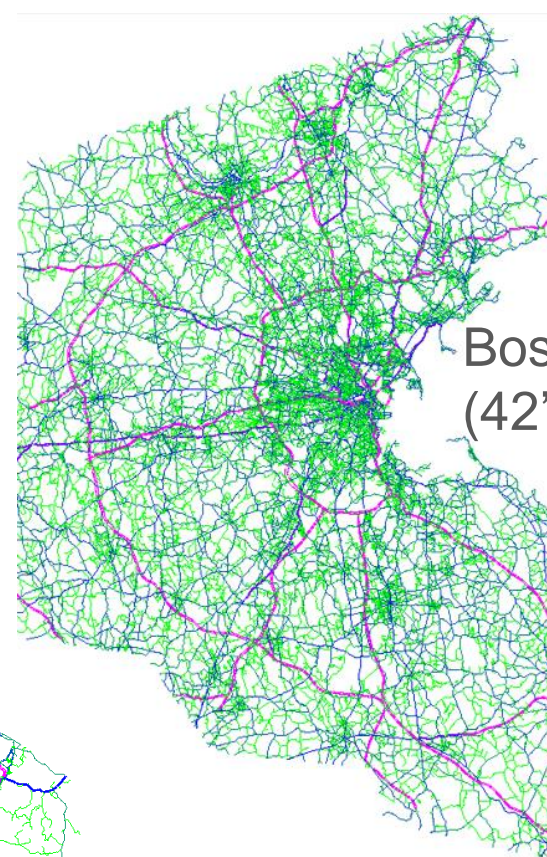
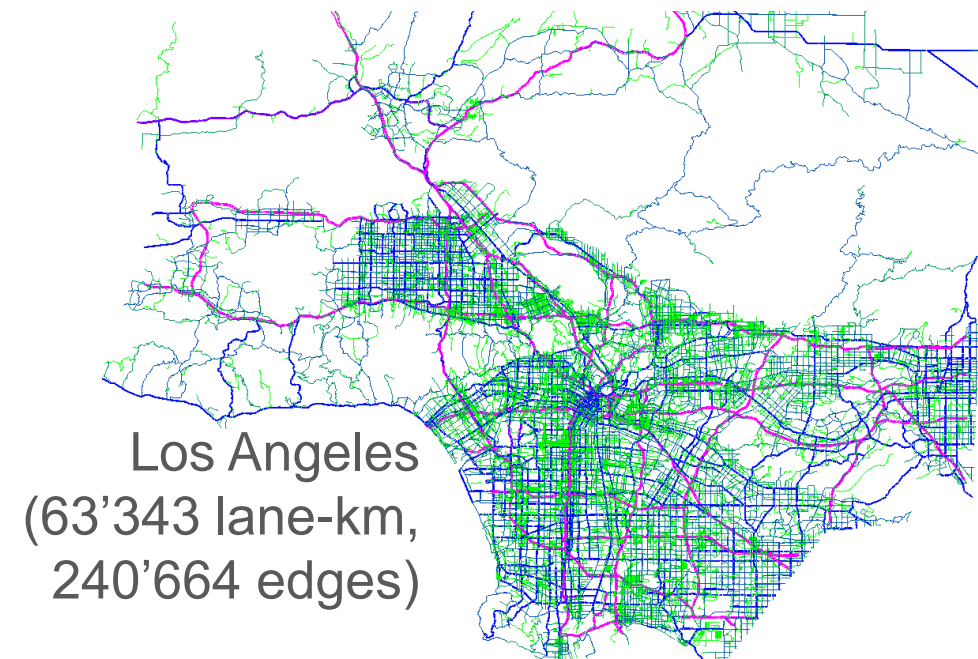
4b

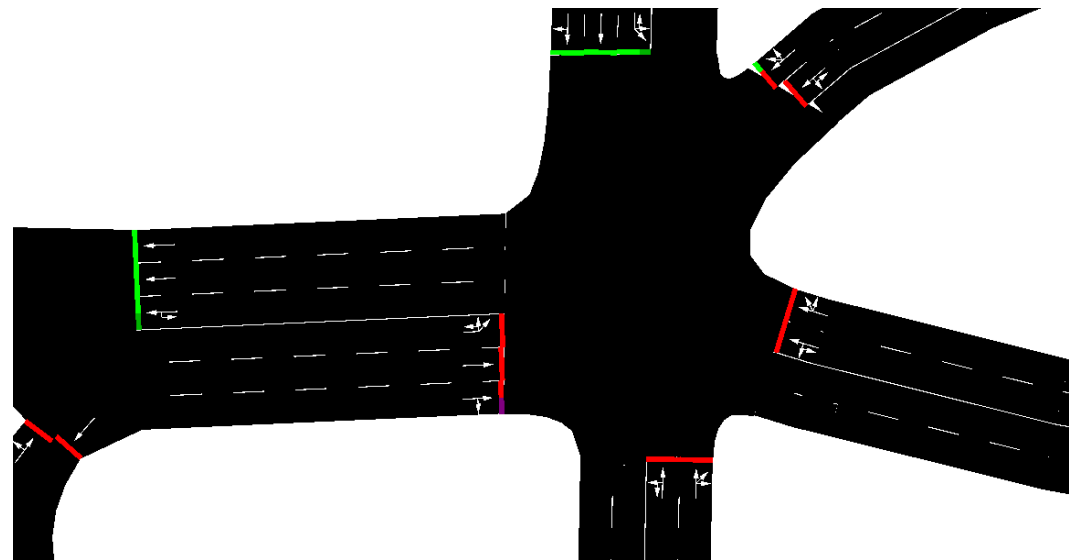
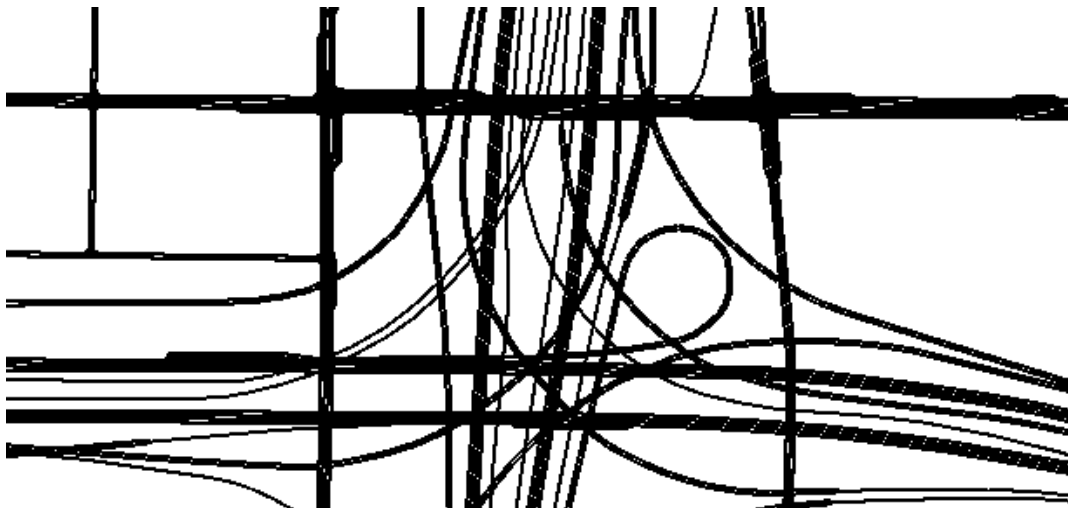


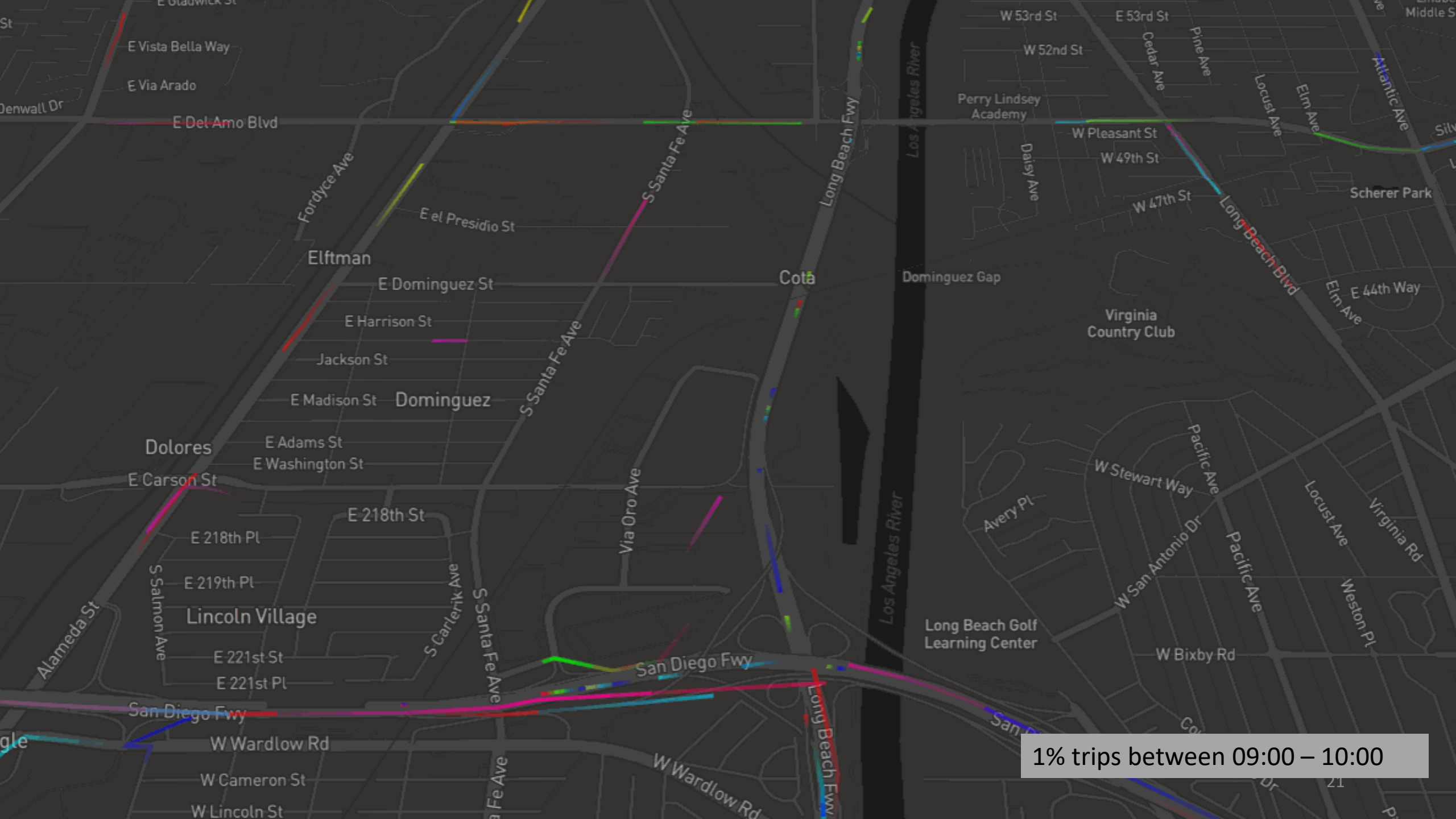
Track
percolation
metrics

- **Calibrated demands from CDR**
 - derived in Toole et al. (2015)
 - $\sim 1\text{km}^2$ & 1h resolution (04:00-11:00)
- **OSM derived network**
 - road classes residential*-highway
 - lanes, speed limits, traffic signals, priorities
- **SUMO mesoscopic model**
 - state-dependent queueing model
 - 3 main parameters (2 headways, 1 tls)
 - periodic, stochastic routing

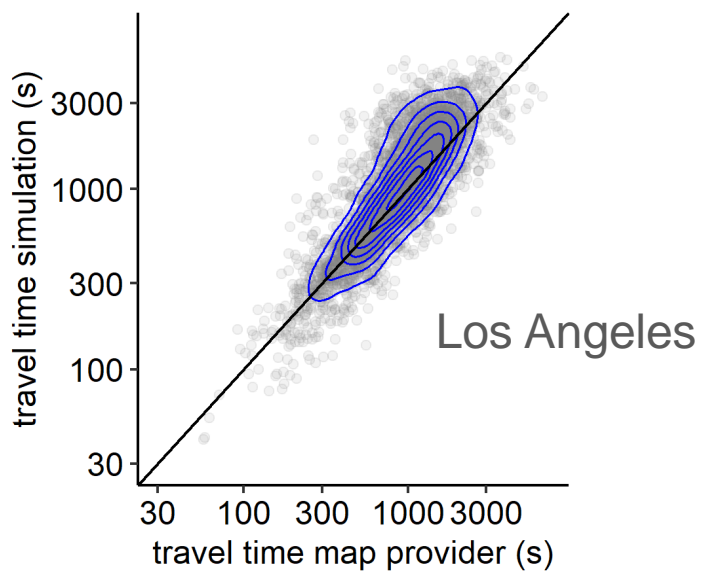
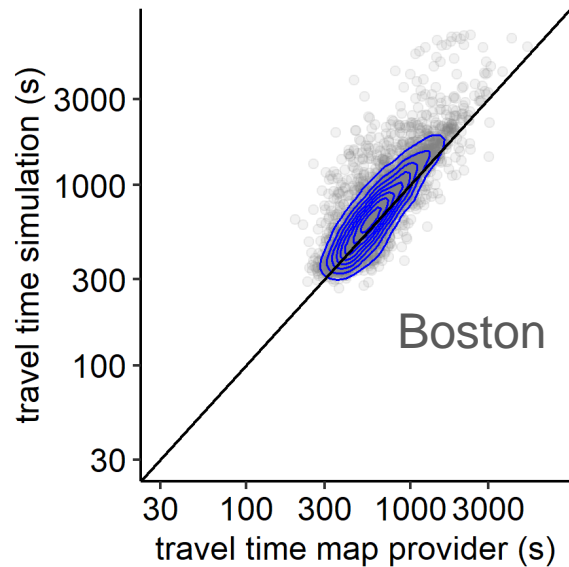
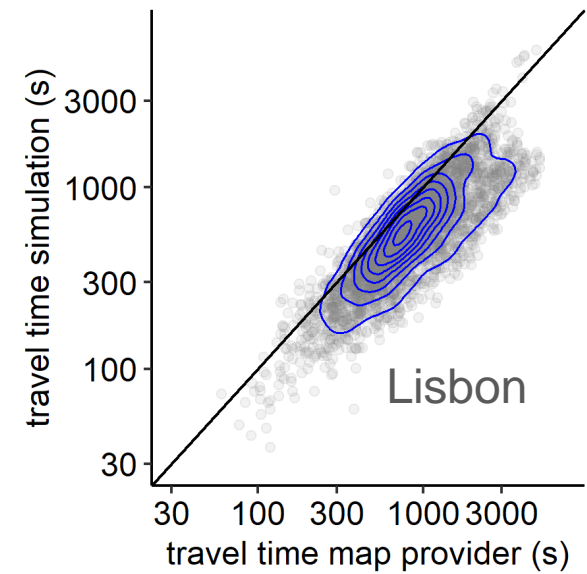
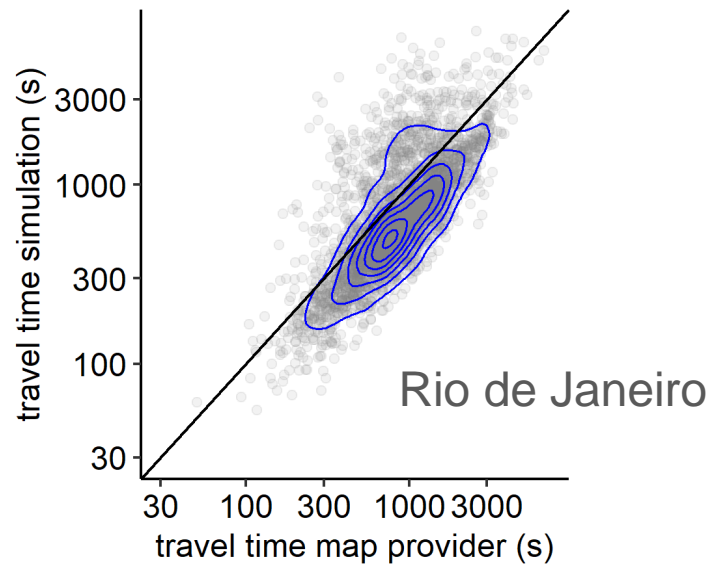
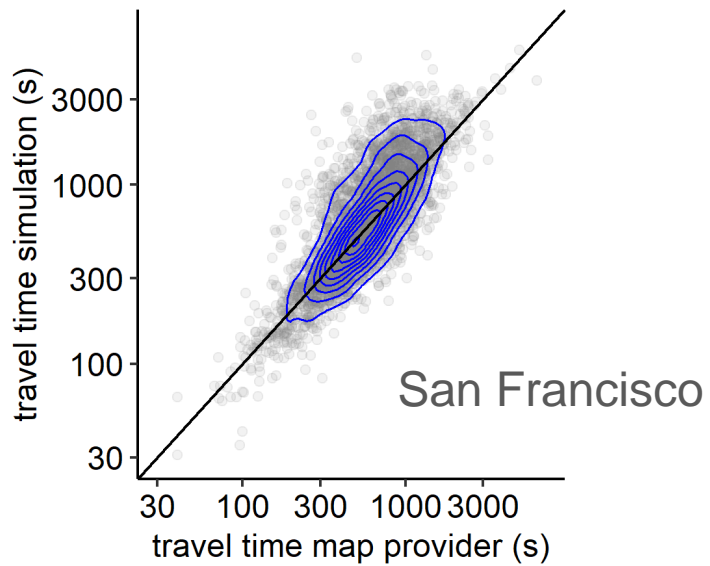








1% trips between 09:00 – 10:00



Travel time comparison

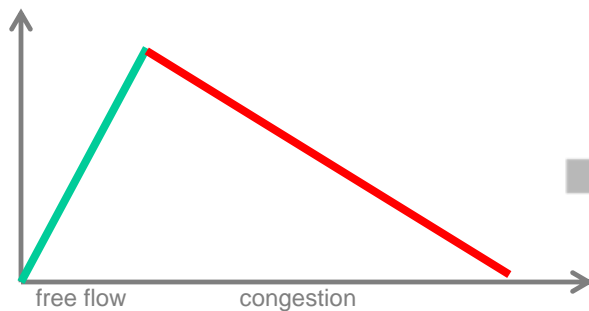
- Google API
- 10'000 random OD
- actual travel departure
- trip > 1km

1



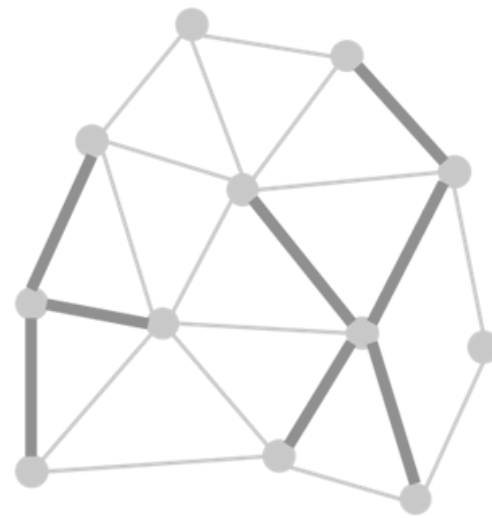
Run realistic
large-scale
simulation

2

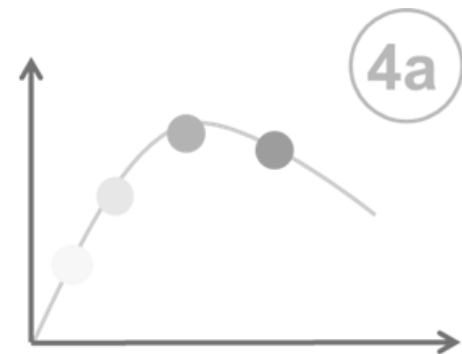


Label
congested
links

3

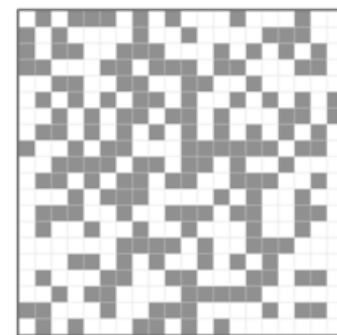


Identify
congested
clusters



Track traffic
performance

4b



Track
percolation
metrics



SPEED INDEX at: 4H 0M 0S

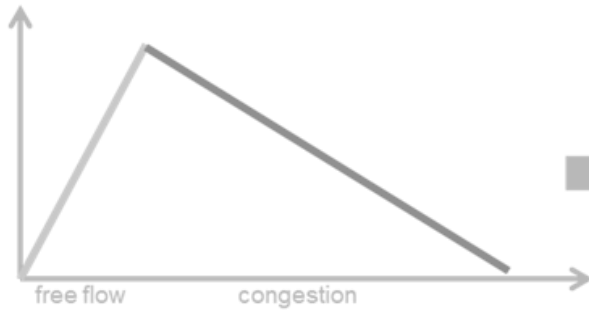
1



Run realistic
large-scale
simulation



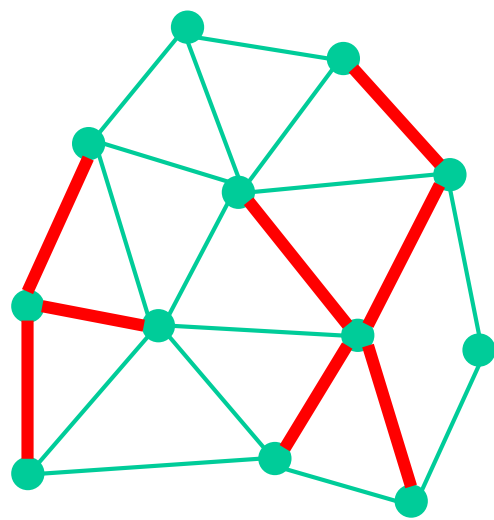
2



Label
congested
links



3



Identify
congested
clusters

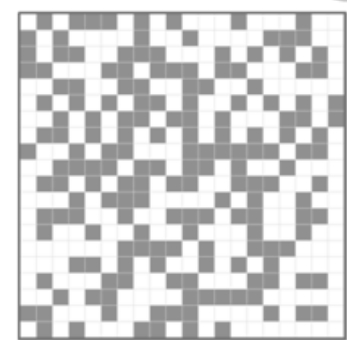


4a

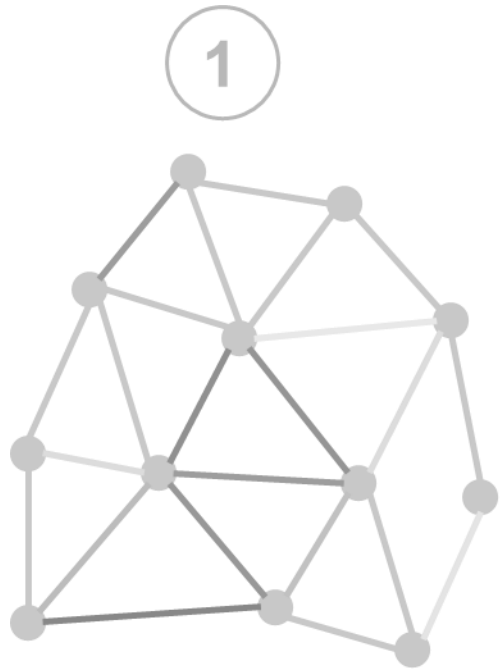


Track traffic
performance

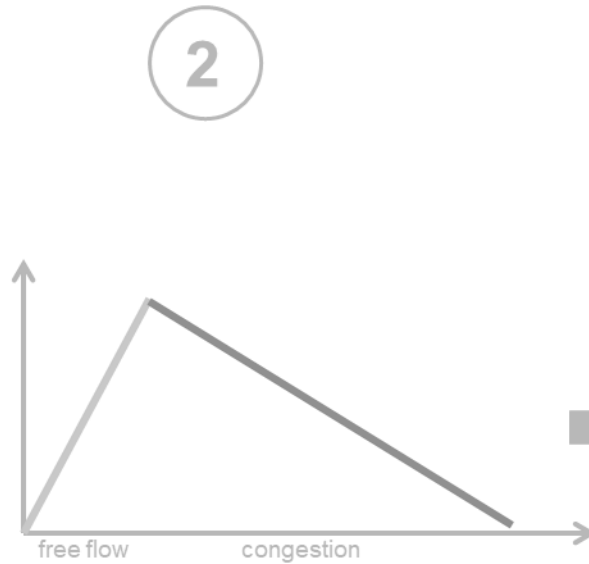
4b



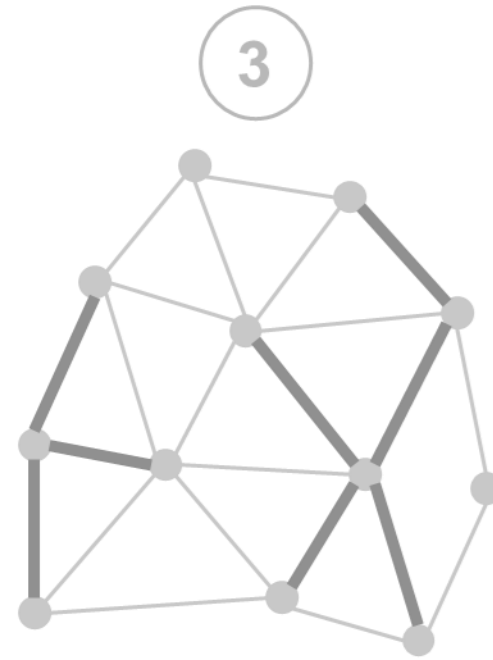
Track
percolation
metrics



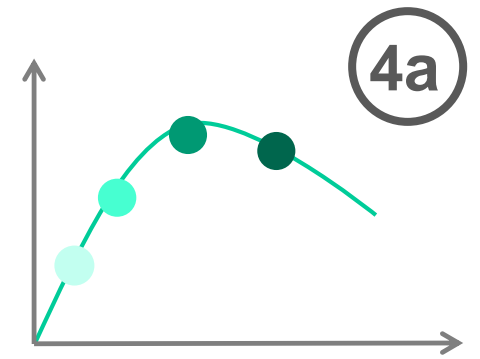
Run realistic
large-scale
simulation



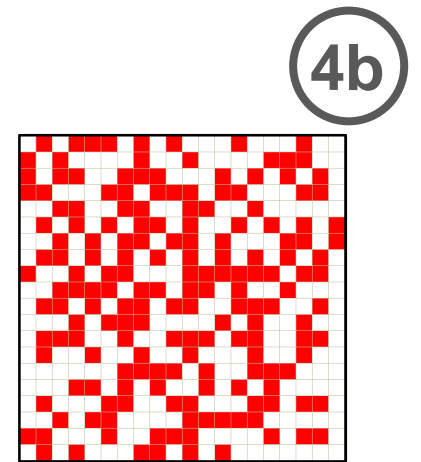
Label
congested
links



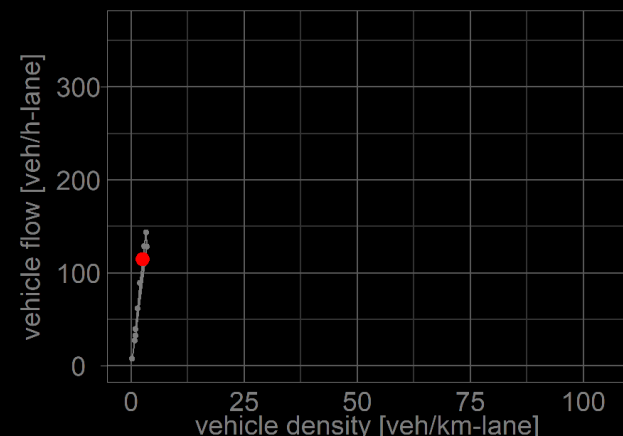
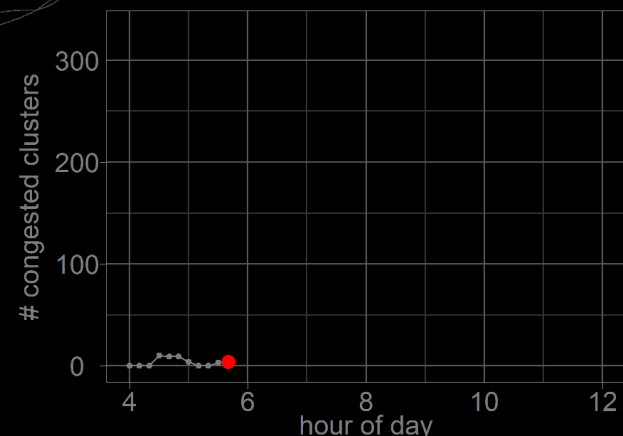
Identify
congested
clusters

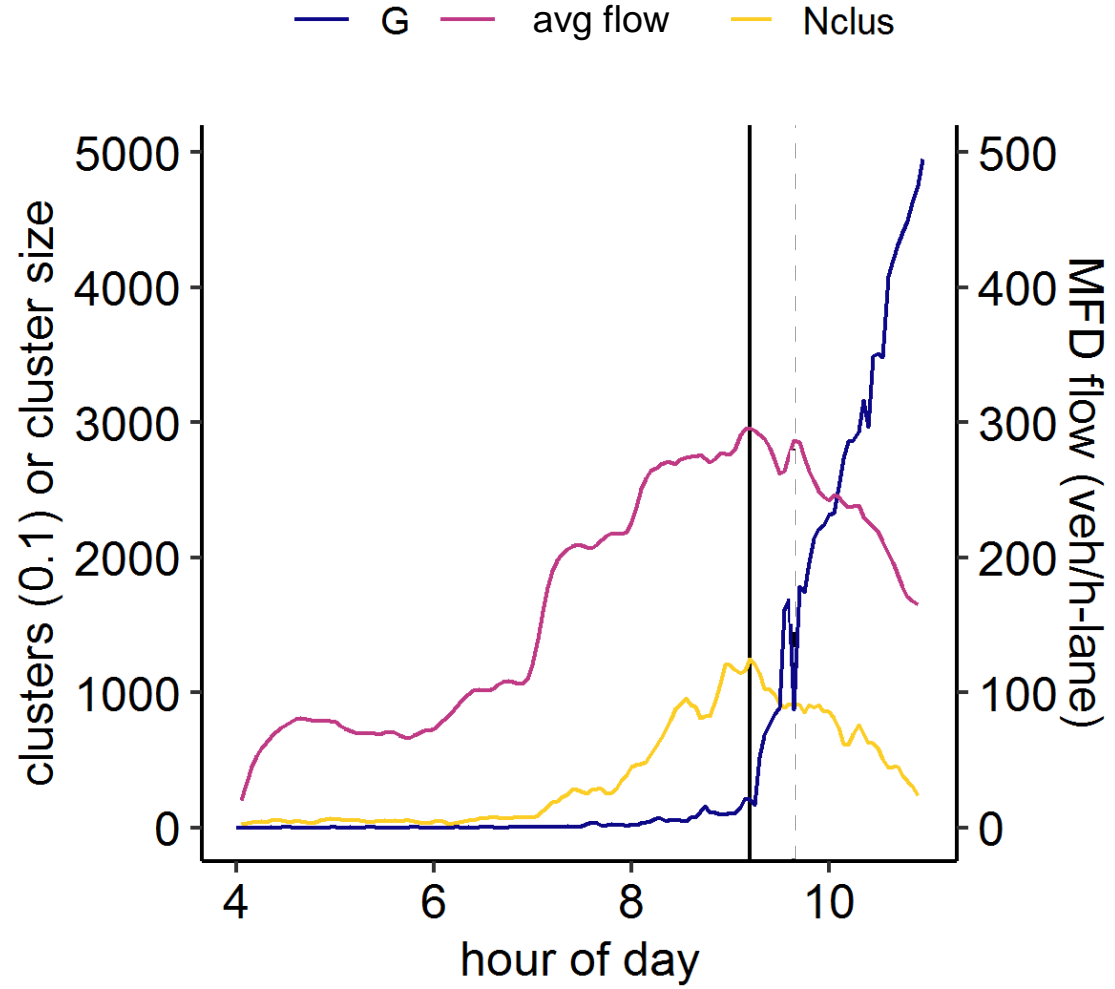


Track traffic
performance

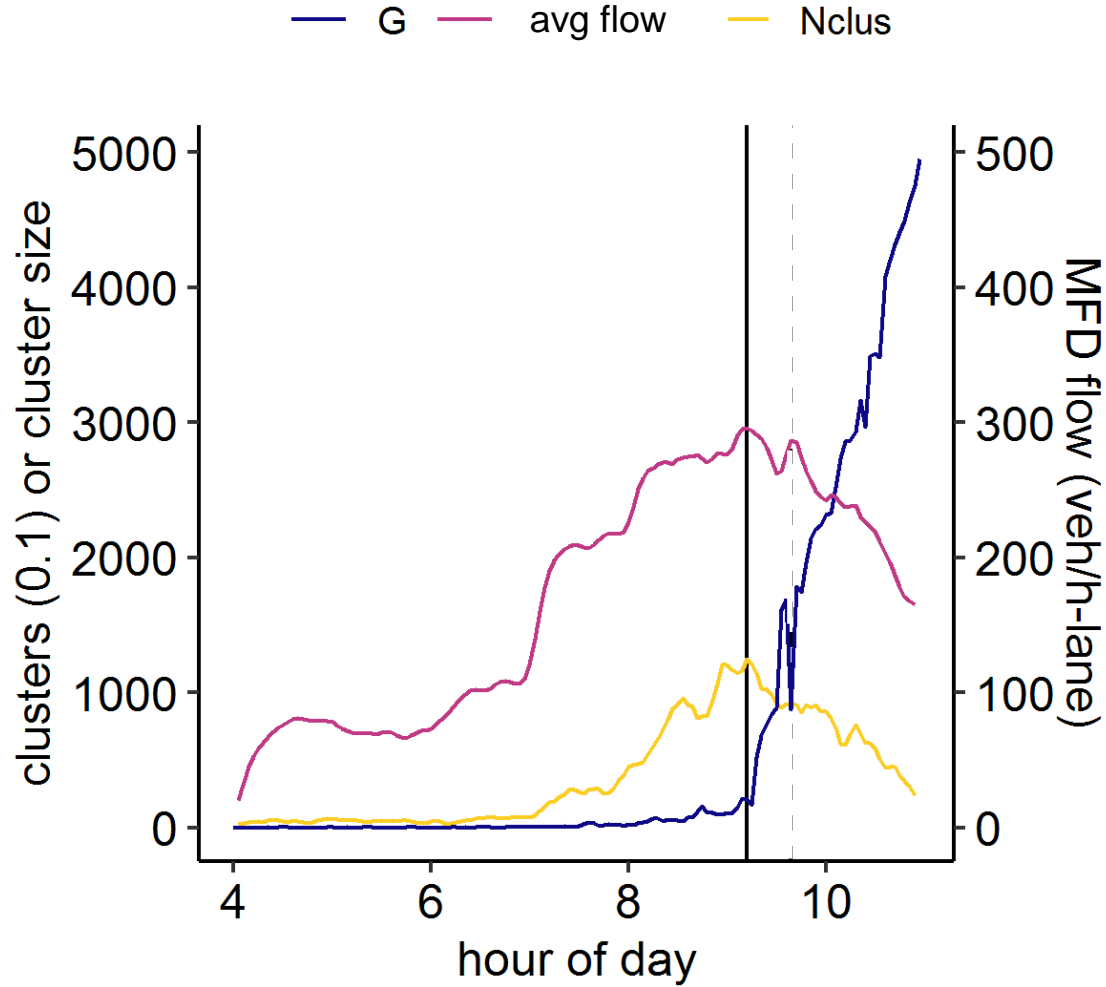


Track
percolation
metrics

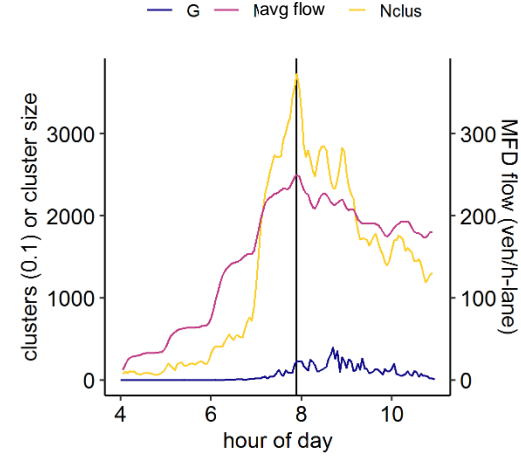




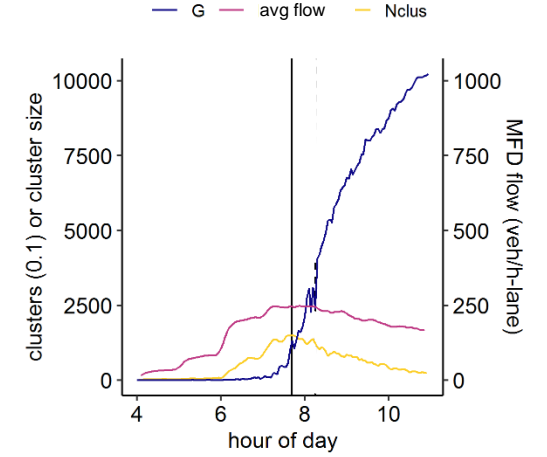
Rio de Janeiro



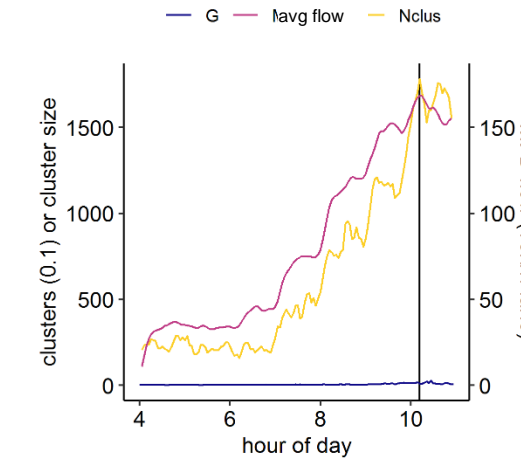
Rio de Janeiro



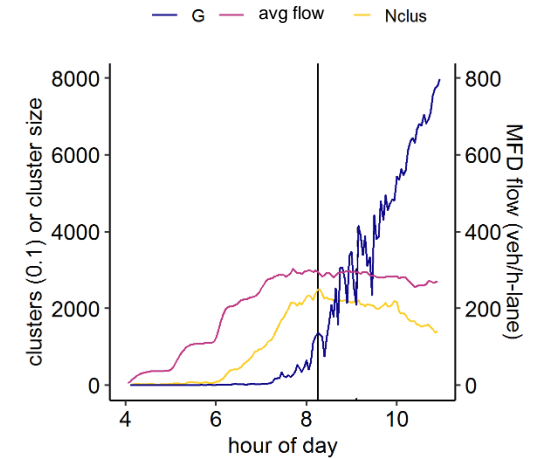
Boston



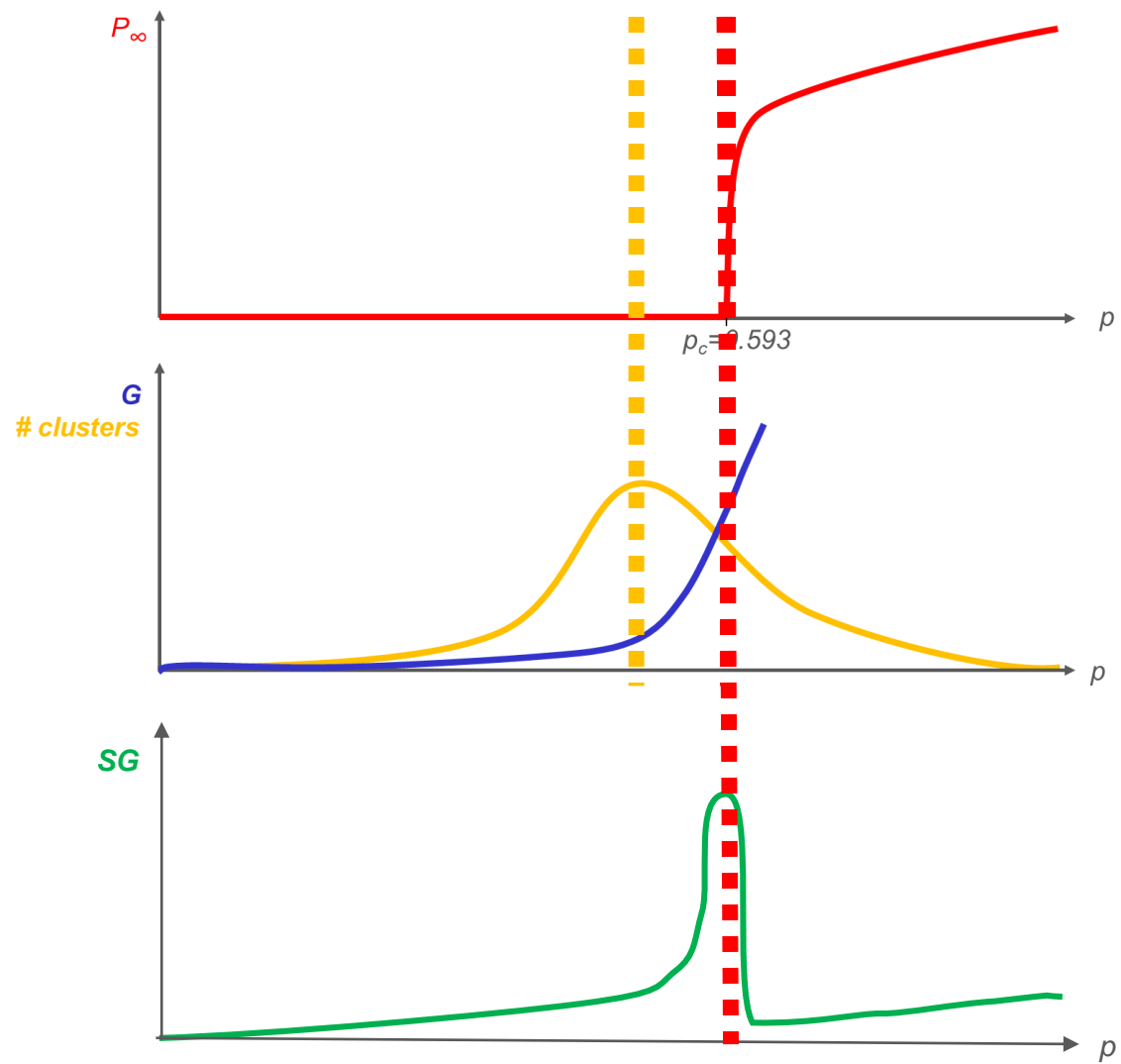
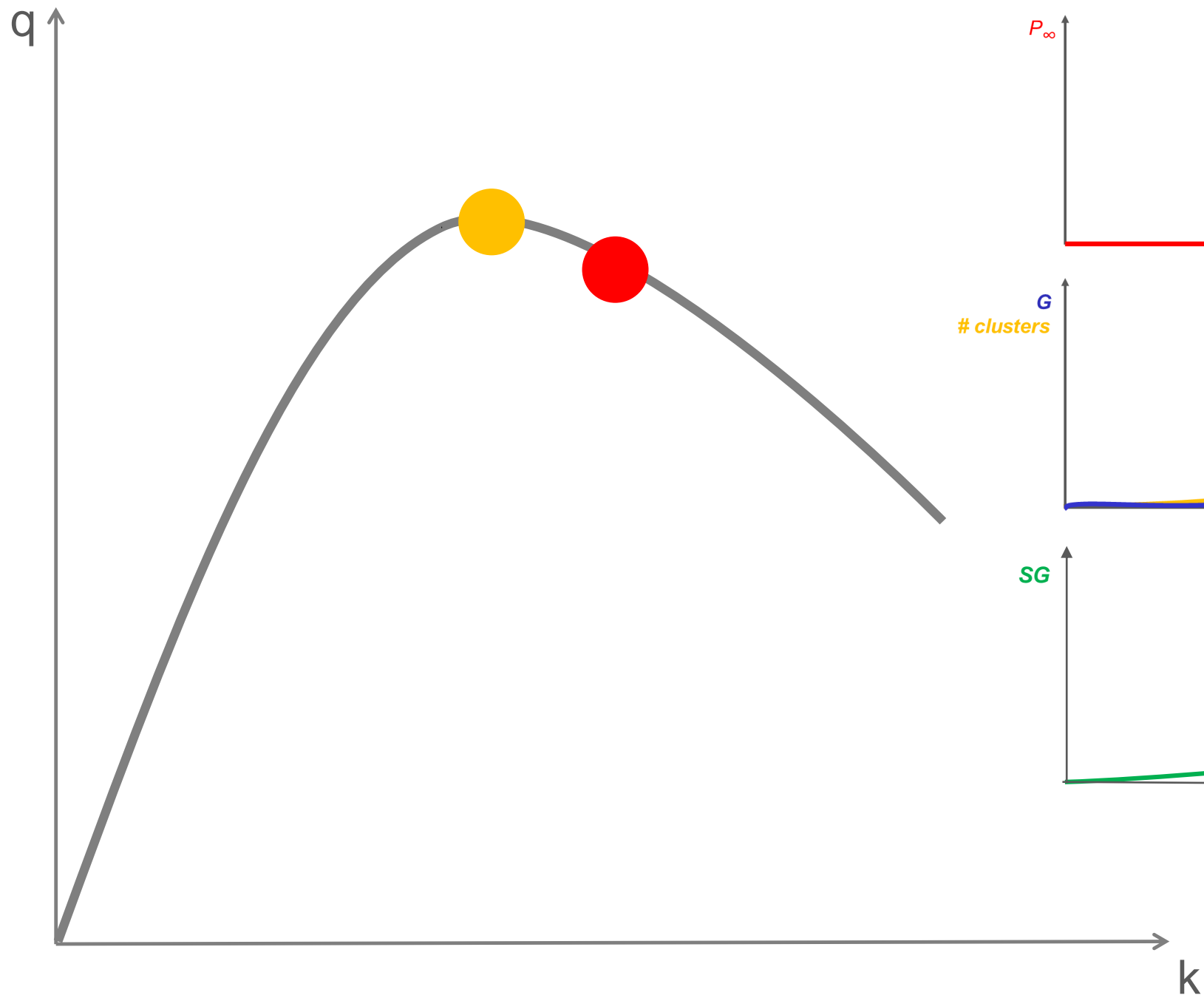
San Francisco



Lisbon



Los Angeles



ROAD NETWORK CAPACITY: *ARE WE THERE YET?*

- Factors affecting capacity
- Propagation of congestion
- Point of no-return?

Thanks

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